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GRC Main Gate Security Project - Phase 1

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SUMMARY OF WORK

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1.1 SUMMARY

The work to be performed under this project consists of providing the labor, equipment, and materials to construct a new traffic entrance to replace the existing intersection of Brookpark Road and Walcott Road, as well as underground utilities infrastructure work that should be completed in preparation for roadway and building construction that will occur in subsequent phases.

Detailed summary of scope includes the following:

a. Concrete paving connecting the Glenn Research Center to Brookpark Road. The existing guard station and parking lot will also remain in operation through the construction phase. Two lanes of both the proposed new northbound and southbound Walcott Road will be constructed up to the intersection of Underpass Road. In addition, portions of new Walcott Road connecting at the south end with Taylor Road, Stratton Road, and the Main Hangar Parking Lot will be constructed. These roads will be constructed with full depth concrete in accordance with ODOT specifications. Phase 1 scope will include demolition in the southwestern portion of the site and limited construction of pavement, islands and sidewalks. Demolition will consist of full depth asphalt removal and replacement with concrete pavement in accordance with ODOT standards. The existing road to the sanitary lift station will be resurfaced with asphalt pavement.

b. Storm drainage will be provided in the roadway with catch basins provided on both sides of the curb line at approximately 300' intervals. Roadways will be designed with a centerline crown and a 2% cross slope. Storm flow will be carried in PVC piping with incrementally increasing sizes and connect to the existing 60" main with outfall on the Rocky River.

c. Installation of traffic signals at the intersection of Brookpark Road and Walcott Road.

d. Installation of traffic signals at the intersection of Taylor Road and Stratton Road.

e. In preparation for the future construction of the new Gatehouse, an existing area of moist, unconsolidated, cohesive fill must be stabilized. The existing area extending a distance of 6 feet beyond the footprint of the Gatehouse will be excavated to a depth of 10 feet. Outside this area, the excavation will be laid back at a 1:1 slope. The excavated soil will be spread nearby and air-dried. Once the soil has reached its optimum moisture content, as determined by in-field testing, the soil will be replaced in the excavation and compacted to achieve the stated percentage of its maximum density.

f. ELECTRICAL: Phase I site electrical scope will include:

1. Construction of a new duct bank consisting of (2)-4" conduits

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from existing Power Manhole (PMH #38) to the location of the future transformer and generator for the new Gatehouse.

2. Construction of a new duct bank consisting of (2)-4" conduits from the location of the future transformer and generator to the area of the new Gate House.

3. Construction of a new duct bank consisting of (2)-4" conduits from existing Telephone Manhole (TMH #3) to a point in the vicinity of the Mechanical Room of the new Gatehouse.

4. Construction of a new duct bank consisting of (4)-2" conduits for future wiring to PTZ(pan/tilt/zoom) cameras and other security/access control devices that will be provided in a subsequent phase. Duct bank will be run from the northern edge of the new Gate House parking lot (constructed in future phase) to the traffic island on new Walcott Road. A branch duct bank will extend to the vicinity of the future new truck inspection circle.

5. Construction of a new duct bank consisting of (2)-4" conduits near the intersection of Brookpark Road and Walcott Road to facilitate the installation of electrical circuits and data for sign features and lighting that will be provided in a subsequent phase.

6. Existing manholes will be adjusted to grade as necessary for the new construction.

g. Phase I utilities construction will establish a new underground "Utility Corridor" to serve the new Gatehouse and future Shipping and Receiving Facility (SARF). The utility corridor will be an approximately 50 foot wide space between Walcott Road and the proposed East access road to the future SARF.

h. SANITARY FORCE MAIN: Installation of a new 12 inch sanitary force main. The existing force main will be abandoned in place. The new force main will be routed from the existing Building 25 Lift Station under the future truck inspection lane to the utilities corridor between the future SARF access road and new Walcott Road, then under the Brookpark Road in a casing pipe installed by boring. On the North side of Brookpark Road, the force main will be routed in parallel to the abandoned-in-place line, bypass an existing line that serves Buildings 500 and 501 and tie in at the existing gravity manhole where the effluent continues to the City of Cleveland sanitary system. The existing force main will remain active between the connection for Buildings 500/501 and the existing Cleveland manhole. Provisions will be made in the new force main pipeline to accommodate a future pumped sanitary tie-in from the proposed SARF. Cleanouts and air vents will be installed along the pipeline, accessible by way of new manholes.

i. Construction of a new 4" gravity sewer line to the existing Sewage Pumping Station from the vicinity of the proposed Gatehouse and capped for future connection at the Gatehouse. Elevations of existing manhole covers which fall within the boundaries of the new paving will be reset to finish elevation.

j. Construction of a new 4" domestic water line from an existing 24" main located southeast of the new Gatehouse to the vicinity of the new Gatehouse and capped. This 4" line will serve as supply for fire protection and domestic water. A new detector check/backflow preventer assembly will be

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installed in a subsequent phase. In addition, an existing water line access box located at the revised entrance to the campus will be reset to the new finish elevation.

k. Construction of a new 2" gas line from a hot tap of the existing carbon steel high pressure gas main near the intersection of Walcott Road and Taylor Road to the vicinity of a new emergency generator south of the proposed Gatehouse location. The gas line will include taps for a future tie-in to the Gatehouse and the future emergency generator in subsequent phases. The gas line will require a new pressure reducing station to provide gas service at 15 inches W.C. pressure. The pressure reducing station will be installed in the vicinity of the new Gatehouse.

l. Installation of two 12" carbon steel casing pipes will be installed from the vicinity of the new Gate House, under new Walcott Road toward the proposed location of the geothermal field for future tie-in.

m. LEED EXEMPTION: Although the overall Main Gate Security Project has an objective of attaining LEED certification, the Phase I scope has been exempted from implementing LEED requirements at this time. Documentation of LEED related items will be maintained for use in submissions made in a subsequent phase.

n. LANDSCAPING: Full landscape development will be included in a subsequent phase to coordinate the layout and installation of the planting. For Phase I, all disturbed areas will be temporarily seeded for proper erosion control.

o. Contractors shall provide a deductive price for the possibility of removing the described portions of scope.

OPTION 1 Deduct Brookpark Road Walcott Road Intersection: See Site Development Plan. Defer demolition and new pavement at Brookpark Road to indicated mark. Defer installation of new traffic signal equipment and underground conduit installation.

OPTION 2 Deduct Southwest Area Demolition/Restoration: See Site Development Plan. Defer all demolition and repavement in the area of the intersection of Walcott Road and Stratton Road including all sidewalks and demolition of the Lewis Field sign.

OPTION 3 Deduct Force Main Installation: See Sanitary Site Plan Drawings. Defer all work associated with installation of the 12" sanitary force main including road closures and tie-ins.

OPTION 4 Deduct Installation of Traffic Barriers: See Site Development Plan. Defer installation of two vehicle capture barriers and one embedded wrong way barriers in new Walcott Road located south and east of the proposed new Gatehouse location.

OPTION 5 Deduct East Area Fencing: See Site Development Plan. Defer installation of crash resistant fencing and cable barrier fencing along east property line.

OPTION 6 Deduct for Asphalt Pavement in Lieu of Concrete: See Civil Details. Construct all roadways in indicated asphalt cross section in lieu of the indicated concrete cross section.

p. See Appendix 1 for Proposed Construction Sequence.

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1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Submit the following items to the Contracting Officer:

Utility Outages G
Confined Space Permits G
Connection Requests G
Excavation Permits G
Hot Work Permits G

1.3 CONTRACT DRAWINGS

See Drawing No. 0000-COF00252-G-001 for a list of drawings which are a part of this contract.

Drawings are available from NASA COTR on a CD. Reference publications will not be furnished.

Contractor shall immediately check furnished drawings and notify the Government of any discrepancies.

1.4 WORK RESCHEDULING

Normal duty hours for work shall be from 7 a.m. to 5 p.m., Monday through Friday. Requests for additional work shall require written approval from the Contracting Officer 7 days in advance of the proposed work period. Special permission will be given in other circumstances on a case by case basis.

1.5 ON-SITE PERMITS

1.5.1 Utility Outages and Connection Requests

Work shall be scheduled to hold outages to a minimum.

Utility outages and connections required during the prosecution of work that affect existing systems shall be arranged for at the convenience of the Government and shall be scheduled outside the regular working hours or on weekends.

Requests for utility outages and connections shall be made in writing to the Contracting Officer at least 10 working days in advance of the time required. Each request shall state the system involved, area involved, approximate duration of outage, and the nature of work involved.

1.5.2 Hot Work, Excavation and Confined Space Permits

<u>ACTIVITY</u>	<u>SUBMISSION DATE</u>	<u>SUBMISSION FORM</u>
Hot Work Permits	7 days prior to work	NASA Form C-7A & NASA Form C-7B
Confined Space Permits	7 days prior to work	NASA Form C-199

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<u>ACTIVITY</u>	<u>SUBMISSION DATE</u>	<u>SUBMISSION FORM</u>
Excavation Permits	21 days prior to work	NASA Form C-927

Permits shall be posted at a conspicuous location in the construction area.

Burning of trash or rubbish is not permitted.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

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PROJECT MEETINGS

04/06

PART 1 GENERAL

1.1 SUMMARY

The requirements of this Section apply to, and are a component part of, each section of the specifications.

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

A [Project Submittal Schedule](#) shall be submitted in accordance with paragraph entitled, "Project Meetings," of this section.

The Contractor shall submit a [Monthly Progress Report](#) at the first meeting of each month.

[Two-Week Planning Schedule](#)

[Meeting Minutes](#)

1.3 PRECONSTRUCTION CONFERENCE

The Contractor shall attend a preconstruction conference scheduled by the Contracting Officer. Work shall not commence prior to the conference. Subcontractor representatives shall attend.

Discussion shall address project orientation, personnel contact, safety issues, permits, deficiencies, and the location of the Contractor's office.

1.4 PROJECT MEETINGS

The Contractor shall attend weekly project meetings scheduled by the Government. Subcontractor representatives shall attend.

Prepare a [Two-Week Planning Schedule](#) for each weekly project meeting, highlighting utility outages, material deliveries, subcontractors on site, equipment on site, coordination issues and updates to the master schedule described in Section 01 33 00, "Submittal Procedures".

[Meeting Minutes](#) shall be kept by the Contractor and distributed after concurrence by the COTR.

A [Monthly Progress Report](#) shall be submitted which addresses the progress schedule, potential factors of delay, deficiencies, material delivery schedules, submittals, and safety issues.

A [Project Submittal Schedule](#) shall be submitted showing full coordination with the project schedule. All products and tests under each submittal

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number shall be prioritized and linked to the progress schedule.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

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SECTION 01 33 00

SUBMITTAL PROCEDURES

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PART 1 GENERAL

1.1 SUMMARY

Requirements of this Section apply to, and are a component part of, each section of the specifications.

1.2 SUBMITTALS

A standard transmittal form provided by the Government shall be used to transmit each submittal.

Submittal Description (SD): Drawings, diagrams, layouts, schematics, descriptive literature, illustrations, schedules, performance and test data, and similar materials to be furnished by the Contractor explaining in detail specific portions of the work required by the contract.

The following items, SD-01 through SD-11, are descriptions of data to be submitted for the project. The requirements to actually furnish the applicable items will be called out in each specification.

However, as a minimum, provide test reports, installation, operation and maintenance submittals and manuals as original data bound in three ring binders. Equipment actually installed will be clearly marked.

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Submittals which are required prior to a notice to proceed on a new contract. Submittals required prior to the start of the next major phase of the construction on a multi-phase contract. Schedules or tabular list of data or tabular list including location, features, or other pertinent information regarding products, materials, equipment, or components to be used in the work, submitted prior to contract notice to proceed or next major phase of construction.

SD-02 Shop Drawings

Submittals which graphically show relationship of various components of the work, schematic diagrams of systems, detail of fabrications, layout of particular elements, connections, and other relational aspects of the work. Upon approval by the Government, shop drawings shall be provided in an electronic pdf file format on compact disc(s).

SD-03 Product Data

Data composed of catalog cuts, brochures, circulars, specifications and product data, and printed information in sufficient detail and scope to verify compliance with requirements of the contract documents. Upon approval by the Government, this data shall be provided in an

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electronic pdf file format on compact disc(s).

SD-06 Test Reports

Written reports of a manufacturer's findings of his product during field inspections, attesting that the products are installed in accordance with the manufacturer's installation instructions, shop drawings, or other manufacturer's requirements. Written reports by a general contractor or his subcontractors including daily logs reporting on the progress of daily activities or attesting that the work has been installed in accordance with the contract plans and specifications.

SD-07 Certificates

A document, required of the Contractor, or through the Contractor by way of a supplier, installer, manufacturer, or other Lower Tier Contractor, the purpose of which is to further the quality or orderly progression of a portion of the work by documenting procedures, acceptability of methods or personnel, qualifications, or other verification of quality.

Statements signed by responsible officials of a manufacturer of a product, system, or material attesting that the product, system or material meet specified requirements. Statements must be dated after the award of this contract, name the project, and list the specific requirements which it is intended to address.

SD-08 Manufacturer's Instructions

Preprinted material describing installation of a product, system, or material, including special notices and material safety data sheets, if any concerning impedances, hazards, and safety precautions. These materials shall be provided in an electronic pdf file format on compact disc(s).

SD-10 Operation and Maintenance Data

Data intended to be incorporated in an operations and maintenance manual. Operation and Maintenance Data shall be provided in an electronic pdf file format on compact disc(s).

For each new mechanical or electrical equipment provided, a completed NASA Form C-134 "CMMS Request for Modifications" shall be submitted.

SD-11 Closeout Submittals

Special requirements necessary to properly close out a construction contract. For example, as-built record drawings, manufacturer's help and product lines necessary to maintain and install equipment. Also, submittal requirements necessary to properly close out a major phase of construction on a multi-phase contract.

1.3 PREPARATION

1.3.1 Marking

Prepare, review and stamp with Contractor's approval all specified submittals.

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Permanently mark each submittal to identify it by contract number; NASA Project I.D. number; transmittal date; Contractor's, Subcontractor's, and supplier's name, address(es) and telephone number(s); submittal name; specification or drawing reference; and similar information to distinguish it from other submittals. Submittal identification shall include space to receive the review action by the Contracting Officer.

1.3.2 Drawing Format

Drawing submittals shall be prepared on translucent, reproducible sheets, not less than 8-1/2 by 11 inches nor larger than 30 by 42 inches in size, except for full size patterns or templates. Drawings shall be prepared to accurate size, with scale indicated, unless other form is required. Drawing reproducibles shall be suitable for microfilming and reproduction on the Diazo or Ozalid machines and shall be of a quality to produce clear, distinct lines and letters. Drawings shall have dark lines on a white background.

Copies of each drawing shall have the following information clearly marked thereon:

- a. Job name, which shall be the general title of the contract drawings.
- b. Date of the drawings and revisions.
- c. Name of Contractor.
- d. Name of Subcontractor.
- e. Name of the item, material, or equipment detailed thereon.
- f. Submittal number (e.g., first submittal to last submittal) in a uniform location adjacent to the title block.
- g. Specification section to which submittal applies.
- h. Government contract number shall appear in the margin, immediately below the title block.

Drawings shall be numbered in logical sequence. Contractor may use his own number system. Each drawing shall bear the number of the submittal in a uniform location adjacent to the title block. Government contract number shall appear in the margin, immediately below the title block, for each drawing.

A blank space, no smaller than 4 x 5 inches shall be reserved on the right hand side of each sheet for the Government disposition stamp.

1.3.3 Data Format

Required data submittals for each specific material, product, unit of work, or system shall be collected into a single submittal and marked for choices, options, and portions applicable to the submittal. Marking of each copy of product data submitted shall be identical. Partial submittals will not be accepted for expedition of construction effort.

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1.4 SUBMISSION REQUIREMENTS

1.4.1 Schedules

At the Preconstruction conference, provide, for approval by the Contracting Officer, the following schedule of submittals:

- a. A schedule of shop drawings and technical submittals required by the specifications and drawings. Indicate the specification or drawing reference requiring the submittal; the material, item, or process for which the submittal is required; the "SD" number and identifying title of the submittal; the Contractor's anticipated submission date and the approval need date.
- b. A separate schedule of other submittals required under the contract but not listed in the specifications or drawings. Schedule will indicate the contract requirement reference; the type or title of the submittal; the Contractor's anticipated submission date and the approved need date (if approval is required).
- c. Submittals called for by the contract documents will be listed on one of the above schedules. If a submittal is called for but does not pertain to the contract work, the Contractor shall include the submittal in the applicable schedule and annotate it "N/A" with a brief explanation. Approval of the schedules by the Contracting Officer does not relieve the Contractor of supplying submittals required by the contract documents but which have been omitted from the schedules or marked "N/A".
- d. Re-submit copies of both schedules and annotate monthly by the Contractor with actual submission and approval dates. When all items on a schedule have been fully approved, no further re-submittal of the schedule is required.

1.4.2 Drawings Submittals

Submit 6 blackline or blue-line opaque prints of each drawing. 3 prints, marked with review notations by the Contracting Officer, will be returned to the Contractor. All required installation, fabrication and connection drawings shall be submitted and approved prior to the start of work detailed on these drawings.

1.4.3 Data Submittals

Submit Five complete sets of indexed and bound product data. Three sets, marked with review notations by the Contracting Officer, will be returned to the Contractor.

At the completion of the project the Contractor shall submit 2 sets of bound data along with 2 CDs containing PDF files of all data submitted.

1.4.4 Samples

Submit one set of identified samples. A copy of the transmittal form, marked with review notations including selections by the Contracting Officer, will be returned to the Contractor.

Samples that are intended or permitted to be returned and actually

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incorporated in the work are so indicated in the individual technical sections. These samples will be returned to the Contractor, at his expense, to be clearly labeled, with installation location recorded. Samples shall be in undamaged condition at the time of installation.

Where mockups and similar large samples are required by individual technical sections, it is recognized that these are a special type of sample which cannot be readily "transmitted" as specified for submittal of samples. Otherwise, and except as indicated in the individual technical sections, the requirements for samples shall be complied with and a transmittal form shall be processed for each mockup, to provide a record of the activity.

1.5 GOVERNMENT'S REVIEW

1.5.1 Review Notations

Contracting Officer will review submittals and provide pertinent notation within 14 calendar days after date of submission. Submittals will be returned to the Contractor with the following notations:

- a. Submittals marked "approved" authorize the Contractor to proceed with the work covered.
- b. Submittals marked "approved as noted" authorize the Contractor to proceed with the work covered provided he takes no exception to the corrections. Notes shall be incorporated prior to submission of the final submittal.
- c. Submittals marked "return for correction" require the Contractor to make the necessary corrections and revisions and to re-submit them for approval in the same routine as before, prior to proceeding with any of the work depicted by the submittal.
- d. Submittals marked "not approved" or "disapproved" indicate noncompliance with the contract requirements and shall be re-submitted with appropriate changes. No item of work requiring a submittal shall be accomplished until the submittals are approved or approved as noted.
- e. Contractor shall make corrections required by the Contracting Officer. If the Contractor considers any correction or notation on the returned submittals to constitute a change to the contract drawings or specifications; notice as required under the clause entitled, "Changes" shall be given to the Contracting Officer. Approval of the submittals by the Contracting Officer shall not be construed as a complete check, but will indicate only that the general method of construction and detailing is satisfactory. Contractor shall be responsible for the dimensions and design of connection details and construction of work. Failure to point out deviations may result in the Government requiring rejection and removal of such work at the Contractor's expense.
- f. If changes are necessary to approved submittals, the Contractor shall make such revisions and submission of the submittals in accordance with the procedures above. No item of work requiring a submittal change shall be accomplished until the changed submittals are approved.

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1.6 PROGRESS SCHEDULE

1.6.1 Bar Chart

- a. Submit the progress chart, for approval by the Contracting Officer, at the Preconstruction Conference in one reproducible and 4 copies.
- b. Prepare the progress chart in the form of a bar chart utilizing form "Construction Progress Chart" or comparable format acceptable to the Contracting Officer.
- c. Include no less than the following information on the progress chart:
 - (1) Break out by major headings for primary work activity.
 - (2) A line item break out under each major heading sufficient to track the progress of the work.
 - (3) A line item showing contract finalization task which includes punch list, clean-up and demolition, and final construction drawings.
 - (4) A materials bar and a separate labor bar for each line item. Both bars will show the scheduled percentage complete for any given date within the contract performance period. Labor bar will also show the number of men (man-load) expected to be working on any given date within the contract performance period.
 - (5) The estimated cost and percentage weight of total contract cost for each materials and labor bar on the chart.
 - (6) Separate line items for mobilization and drawing submittal and approval. (These items are to show no associated costs.)
- d. Update the progress schedule in one reproduction and 4 copies every 30 calendar days throughout the contract performance period.

1.7 STATUS REPORT ON MATERIALS ORDERS

Within 21 calendar days after notice to proceed, submit, for approval by the Contracting Officer, an initial material status report on all materials orders. This report will be updated and re-submitted every 30 calendar days as the status on material orders changes.

Report shall list, in chronological order by need date, materials orders necessary for completion of the contract. The following information will be required for each material order listed:

- a. Material name, supplier, and invoice number.
- b. Bar chart line item or CPM activity number affected by the order.
- c. Delivery date needed to allow directly and indirectly related work to be completed within the contract performance period.
- d. Current delivery date agreed on by supplier.

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- e. When item d exceeds item c, the effect that delayed delivery date will have on contract completion date.
- f. When item d exceeds item c, a summary of efforts made by the Contractor to expedite the delayed delivery date to bring it in line with the needed delivery date, including efforts made to place the order (or subcontract) with other suppliers.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

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SECTION 01 33 29

LEED(TM) DOCUMENTATION

07/06

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

U.S. GREEN BUILDING COUNCIL (USGBC)

LEED (2002; R 2005) Leadership in Energy and Environmental Design(tm) Green Building Rating System for New Construction (LEED-NC)

LEED-NC (2002; R 2005) Leadership in Energy and Environmental Design(tm) Green Building Rating System for New Construction (LEED-NC)

LEED Reference Guide (2005) LEED-NC Reference Guide for New Construction

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

LEED Implementation Plan; LEED

SD-11 Closeout Submittals

LEED Documentation Notebook; LEED

1.3 DESCRIPTION

This project has been designed for, and shall be developed for a sustainable rating of silver in accordance with **LEED-NC** Version 2.2. Table 1 (see paragraph Table) identifies the **LEED** credit items that are designed into or otherwise required for this project. No variations or substitutions to the **LEED** credits identified for this contract shall be allowed without written consent from the Contracting Officer. Should there be a case where there is any problem meeting the full requirements of a **LEED** credit identified for this project in Table 1, the Contractor must bring this to the attention of the Contracting Officer immediately.

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1.3.1 Credit Validation

This project will be registered with USGBC in a future phase for validation of credits earned. Contractor is not responsible for registering the project with USGBC or for paying project registration fees to USGBC. Format and content of all construction documentation must be in accordance with the **LEED Reference Guide** requirements for supporting data required in event of USGBC audit of the particular credit. Contractor is required to coordinate through the Contracting Officer with Government's **LEED** consultant on assuring assembled data is acceptable to USGBC and responding to USGBC requests for additional construction data in the course of seeking project certification. Design documentation will be provided by others.

1.3.2 Contractor Responsibilities

Some **LEED** credits are inherent in the design provided and require no further submittal or documentation. For these credits, the Contractor notify the Contracting Officer in advance of selection of any specified material or use of any permissible construction methods that may result in a deviation from the LEED designer intent. Some **LEED** credits involve material selection and are generally identified within the technical sections with the notation "**LEED**," though not specifically identified in all occurrences. Some **LEED** credits are dependent on construction practices.

All LEED credits identified in Table 1 not inherent in the design provided shall be documented by the Contractor. Table 1 provides a general summary of applicable credits. Detailed submittal requirements are contained in the LEED Reference Guide and in the technical sections.

In all cases where a material, product, or execution requirement is identified by "**LEED**" in the contract documents, additional data or certificates shall be submitted with the individual component or process validating the material or component to the respective **LEED** credit item. These additional data or certificates shall be separable from the other submitted data and a copy shall be included in the **LEED** Documentation Notebook in addition to the distribution indicated in the submittal register.

1.4 **LEED IMPLEMENTATION PLAN**

LEED Implementation Plan shall be submitted within 30 days after notice to proceed. The plan, when completed, shall provide a detailed description of all activities that relate to accomplishing project **LEED** requirements, including construction practices, procurement practices, and proposed submittals and documentation for each **LEED** credit. Plan shall also include the following:

- a. Name of individual(s) on the Contractor's staff responsible for ensuring **LEED** credits and prerequisites are earned and responsible for assembling documentation.
- b. Templates to be used for tracking **LEED** credits. Listing of documents to be provided for each credit and schedule for their inclusion in LEED Documentation Notebook. **Include proposed materials, associated estimated costs, and details necessary for LEED calculations in order to determine if the listed materials can be expected to achieve the project goal.**

c. List of all plans required in the technical sections for LEED credit. Proposed submittal date for each plan. These shall be added to the LEED Implementation Plan as they are completed.

d. Implementation plan for cumulative materials credits, which shall use applicable template with proposed materials, associated estimated costs, and details necessary for LEED Calculations added in order to determine if the listed materials can be expected to achieve the project goal. Submit cumulative materials implementation plans before materials purchasing begins.

1.5 LEED DOCUMENTATION NOTEBOOK

The Contractor shall prepare a comprehensive notebook documenting compliance for each LEED credit identified in Table 1. LEED Documentation Notebook shall be formatted to match LEED numbering system and tabbed for each credit and prerequisite. LEED documentation in notebook shall contain up to date information through the previous week's work, and at least one set shall be available on the jobsite at all times. Completed pages shall be prevented from being altered. If the Contractor fails to maintain the LEED Documentation Notebook as specified herein, the Contracting Officer will deduct from the monthly progress payment an amount representing the estimated cost of maintaining the Notebook. This monthly deduction will continue until an agreement can be reached between the Contracting Officer and the Contractor regarding the accuracy and completeness of the Notebook. The original, one copy, and an electronic version on CD of the notebook shall be submitted at project closeout.

1.5.1 Content

Notebook shall include Table 1, applicable product data for material selection, final calculations, certifications for construction practices, procurement data, cumulative calculations and other items as identified in the approved LEED Implementation Plan. Notebook must contain all required data to support full compliance with the indicated LEED credit. LEED credits that are inherent to the design will be documented by the designer of record.

1.5.2 LEED Calculations

Calculations showing compliance with a required LEED credit identified in Table 1 or within the LEED Implementation Plan. Calculations shall be current and available for monthly review. Final calculations shall be included in the LEED Documentation Notebook under the appropriate tab. LEED templates may be used for on-going calculations, if applicable.

1.5.3 Submittals

All "G" designated submittals required for inclusion in the LEED Documentation Notebook shall be separable from other submitted data and shall be included in the LEED Documentation Notebook in addition to the distribution indicated on the submittal register.

1.6 REQUIREMENTS

LEED credits as identified in Table 1 shall be incorporated and documented as required by the Contract documents and in full compliance with the LEED Reference Guide. LEED credits not identified elsewhere in the

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Contract documents and those requiring further instruction are specified below. Refer to the [LEED Reference Guide](#) for further definitions and requirements.

1.6.1 Sustainable Site Prerequisite 1, Construction Activity Pollution Preventions

Contractor shall adopt a plan to implement the measures presented in the Erosion and Sedimentation Control Plan. Provide confirmation of compliance, including on-going maintenance before and after storm events. For this credit, performance is measured for the duration of the project.

1.6.2 Materials and Resources Credit 2, Construction Waste Management

Contractor shall recycle and/or salvage 75% of non-hazardous construction and demolition debris. Develop a Construction Waste Management Plan. The Plan identifies the materials, and if materials are sorted on-site, or off-site by a hired comingled recycler. Identify construction haulers and recyclers to handle the designated materials. Make sure jobsite personnel understand and participate in the program, with updates throughout the construction process. Obtain and retain verification records (waste haul receipts, waste management reports, spreadsheets, etc.) to confirm the diverted materials have been recycled or salvaged as intended. Land clearing debris, including soil, vegetation, rocks, etc. are not to be included.

1.6.2.1 Calculations

Convert all materials to either weight or volume in order to calculate the percentage, but must be consistent throughout the process. Complete the construction waste calculation tables in the Submittal Template. For this credit, performance is measured for the duration of the project.

1.6.3 Materials and Resources Credit 4, Recycled Content

Contractor shall select materials so that the sum of post-consumer recycled content value plus one-half of post-industrial recycled content value constitutes at least 20 percent of the total materials cost for the project. Identify products which contain recycled content and pursue documentation from suppliers, manufacturers and vendors directly or through the subcontractors to confirm the actual recycled content for each product. EPA Comprehensive Procurement Guidelines has a [supplier database](http://www.epa.gov/cpg/products.htm) at www.epa.gov/cpg/products.htm. California Integrated Waste Management Board (CIWMB) Recycled Content Directory also contains product and supplier data at www.ciwmb.ca.gov/rcp.

1.6.3.1 Calculations

[LEED](#) Template forms provided by USGBC shall be used for tracking and documentation. Recycled content value of project materials shall be determined by the method described in the [LEED Reference Guide](#). For this credit, performance is measured for the duration of the project.

1.6.3.2 Substitutions

In the case of conflict between this requirement and individual technical section requirements, Contractor may submit for Government approval proposed alternative products or systems that provide equivalent

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performance and appearance and have greater contribution to project recycled content requirements. All such proposed substitutions shall be submitted with the LEED Implementation Plan accompanied by product data that demonstrates equivalence.

1.6.4 Materials and Resources Credit 5, Regional Materials

Contractor shall select materials so that a minimum of 20 percent (by dollar value) of materials and products for the project are extracted, harvested, or recovered, as well as manufactured, regionally within a 500 mile radius of the project site.

1.6.4.1 Calculations

LEED Template forms provided by USGBC shall be used for tracking and documentation. Amount of regional project materials shall be determined by the method described in the LEED Reference Guide. For this credit, performance is measured for the duration of the project. The general contractor must track the materials cost of each locally harvested and manufactured product that will be applied to the LEED credit.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 COORDINATION MEETINGS

There will be four onsite coordination meetings. The first will be a preconstruction meeting to review the LEED Implementation Plan. The requirements for this meeting may be fulfilled during the coordination and mutual understanding meeting outlined in Section 01 31 19.98 PROJECT MEETINGS. The second will be midway of the construction process. The third will be a pre-closeout meeting to review LEED Documentation Notebook for completeness and identify any outstanding issues relating to final score and documentation requirements. The third is a closeout meeting to review the final LEED Documentation Notebook and LEED Templates. All meetings shall be attended by Contractor's designated individual responsible for LEED documentation, Government representative and Installation representative. At closeout meeting a final score for the project will be determined based on review of project performance and documentation. Contractor shall make a set of contract drawings and specifications available for review at each meeting as well as an updated LEED Documentation Notebook.

3.2 TABLE

LEED credits as identified in Table 1 below are contract requirements and shall be incorporated in full compliance with the LEED Reference Guide.

Table 1 - Phase 1 LEED credits

Sustainable Sites:

SS prerequisite 1 - Construction Activity Pollution Prevention
SS credit 7.1 - Heat Island Effect, Non-Roof

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GRC Main Gate Security Project - Phase 1

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Materials and Resources:

MR credits 2.1, 2.2 - Construction Waste Management, Divert 75% from Disposal
MR credits 4.1, 4.2 - Recycled Content, 20% (post-consumer + 1/2 pre-consumer)
MR credits 5.1, 5.2 - Regional Materials, 20% Extracted, Processed &
Manufacturer Regionally
-- End of Section --

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SECTION 01 35 26.98

GENERAL SAFETY REQUIREMENTS

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PART 1 GENERAL

1.1 SUMMARY

The requirements of this Section apply to, and are a component part of, each section of the specifications.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

10 CFR 20	Standards for Protection Against Radiation
29 CFR 1910	Occupational Safety and Health Standards
29 CFR 1926	Safety and Health Regulations for Construction

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

NASA NHB 1700.1	(1993) (V1-B) NASA Safety Policy and Requirements Documents
GRC-MQSA.001	Glenn Safety Manual

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-06 Test Reports

Records shall be submitted in accordance with paragraph entitled, "[Gas Protection](#)," of this section.

SD-07 Certificates

Statements shall be submitted for the following items in accordance with paragraphs entitled, "Safety Plan" and "Protection Plan," of this section.

[Site Specific Health and Safety Plan G](#)
[Protection Plan G](#)

[License Certificates](#) for radiation materials and equipment shall be submitted by the Contracting Officer prior to the start of work.

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1.3.1 Site Specific Health and Safety Plan

Contractor shall submit a site specific safety plan to the Contracting Officer for approval within 10 working days after award of contract and it must be approved prior to notice to proceed. Compliance to the safety plan is mandatory. A copy of this approved plan shall be maintained in the Contractor's field office. This document will be made available upon request from the Contracting Officer's Technical Representative and the Safety Assurance Office.

The Site Specific Health and Safety plan shall include, as a minimum, the following:

- a. Safety program objectives.
- b. Methods to attain safety objectives.
- c. Responsibility of key personnel for the Contractor.
- d. Safety meetings, surveys, inspections, and reports.
- e. Identification of unusual safety hazards and mitigation plan to allow for safe conduct of work.
- f. Disaster and emergency programs.
- g. Lists of key personnel to be contacted in times of emergency.
- h. Program to show compliance with Federal OSHA Safety and Health Standards 29 CFR 1910 and 29 CFR 1926 and various safety requirements of NASA NHB 1700.1.
- i. Methods to comply with the requirement for immediate reporting of mishaps to the Contracting Officer in accordance with NPD 8621.1G.
- j. Statement that the Contractor will not invalidate the integrity of safety systems without proper authorization.
- j. Procedures for emergency actions to be taken to secure dangerous conditions, to protect personnel, and secure work areas in the event of accident or an act of nature.
- l. Procedures for securing the mishap site so that the area remains secure until arrival of a safety investigator. Mishap site will remain secured until released by the Contracting Officer.
- l. Provide MSDS sheets for all hazardous materials which will be used. Methods for handling and storage shall be identified.

1.3.2 Protection Plan

Structures, utilities, sidewalks, pavements, and other facilities immediately adjacent to excavations shall be protected against damage.

1.4 GENERAL SAFETY PROVISIONS

The GRC Safety Manual, GRC-MQSA.001, is available online at http://smad-ext.grc.nasa.gov/gso/manual/chapter_index.shtml

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Contractor shall take safety and health measures in performing work under this Contract. Contractor shall meet with the Contracting Officer to develop a mutual understanding relative to administration of the safety plan. Contractor is subject to applicable federal, state, and local laws, regulations, ordinances, codes, and orders relating to safety and health in effect on the date of this Contract.

During the performance of work under this Contract, the Contractor shall comply with procedures prescribed for control and safety of persons visiting the project site. Contractor is responsible for his personnel and for familiarizing each of his subcontractors with safety requirements. Contractor shall advise the Contracting Officer of any special safety restriction he has established so that Government personnel can be notified of these restrictions.

1.5 SAFETY LOCKOUT/TAGOUT PROCEDURES

Contractor shall ensure that each employee is familiar with and complies with these procedures and 29 CFR 1910.147.

Contracting Officer will, at the Contractor's request, apply lockout/tagout tags and take other actions that, because of experience and knowledge, are known to be necessary to make the particular equipment safe to work on.

No person, regardless of position or authority, shall operate any switch, valve, or equipment that has an official lockout/tagout tag attached to it, nor shall such tag be removed except as provided in this section.

No person shall work on any equipment that requires a lockout/tagout tag unless he, his immediate supervisor, project leader, or a subordinate has in his possession the stubs of the required lockout/tagout tags.

When work is to be performed on electrical circuits, the work shall be performed only by personnel qualified observing the required safety clearance.

A supervisor who is required to enter an area protected by a lockout/tagout tag will be considered a member of the protected group provided he notifies the holder of the tag stub each time he enters and departs from the protected area.

Identification markings on building light and power distribution circuits shall not be relied on for established safe work conditions.

Before clearance will be given on any equipment other than electrical (generally referred to as mechanical apparatus), the apparatus, valves, or systems shall be secured in a passive condition with the appropriate vents, pins, and locks.

Pressurized or vacuum systems shall be vented to relieve differential pressure completely.

Vent valves shall be tagged open during the course of the work.

Where dangerous gas or fluid systems are involved, or in areas where the environment may be oxygen deficient, system or areas shall be purged, ventilated, or otherwise made safe prior to entry.

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1.5.1 Tag Placement and Removal

Lockout/tagout tags shall be completed in accordance with the regulations in Chapter 9 of the GRC Safety Manual, [GRC-MQSA.001](#) and attached to any device which, if operated, could cause an unsafe condition to exist.

1.6 ACCIDENT TREATMENT AND RECORDS

Contractor shall post emergency first aid and ambulance information at project site.

Emergency response shall require the Contractor to call 911 on a NASA phone or 216 433-2088 on an outside line.

1.7 FIRE PREVENTION AND PROTECTION

Open-flame heating devices will not be permitted except by approval in writing from the Contracting Officer. Approval for the use of open fires and open-flame heating devices will not relieve the Contractor from the responsibility for any damage incurred because of fires.

Burning trash, brush, or wood on the project site shall not be permitted.

1.8 ELECTRICAL

Contractor shall appoint an individual responsible for the electrical safety of each work team to restrict entry to dangerous locations to those authorized by him jointly with the Government.

1.9 UNDERGROUND UTILITIES

Safety clearance from the Contracting Officer is required before any Contractor personnel enters a manhole. Contractor shall contact the Contracting Officer for support services by calling (216) 433-2088 at least 24 hours in advance.

Contractor shall be responsible for removing water and debris before commencement and during execution of work in manholes.

1.10 RADIATION SAFETY REQUIREMENTS

[License Certificates](#) for radiation materials and equipment shall be submitted by the Contracting Officer for all specialized material and equipment that could cause fatal harm to construction personnel or to the construction project.

Workers shall be protected from radiation exposure in accordance with [10 CFR 20](#). Standards for Protection Against Radiation

Loss of radioactive material shall be reported immediately to the Contracting Officer.

Actual exposure of the radiographic film or unshielding the source shall not be initiated until after 5 p.m. on weekdays.

In instances where radiography is scheduled near or adjacent to buildings or areas having limited access or one-way doors, no assumptions shall be made as to building occupancy. Where necessary, the Contracting Officer will direct the Contractor to conduct an actual building entry, search, and

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alert. Where removal of personnel from such a building cannot be accomplished and it is otherwise safe to proceed with the radiography, a fully instructed employee shall be positioned inside such building or area to prevent exiting while external radiographic operations are in process.

1.11 FACILITY OCCUPANCY CLOSURE

Streets, walks, and other facilities occupied and used by the Government shall not be closed or obstructed without written permission from the Contracting Officer.

1.12 PROTECTION OF WORK

Prior to performing any excavation work or any surface penetrations 6 inches or deeper (such as driving stakes more than 6 inches in the ground) on any ground surface, the Contractor shall obtain from the inspection office the current subsurface utility drawing of the particular area to be worked on. Contractor shall stake out subsurface high voltage cables, communication cables, and pipe lines indicated within the scope of the work contemplated. After exposure, the Contractor shall obtain agreement from the Contracting Officer on how much closer to cable or pipe the excavations can be permitted.

Contractor shall notify the Contracting Officer, 48 hours prior to the start of excavation work or surface penetration, to enable the Contracting Officer to review measures being taken to prevent hazard to employees and possible damage to subsurface utilities. Where emergency conditions preclude the 48 hours advance notification, the Contractor shall immediately inform the Contracting Officer of his intention to initiate work prior to actual start of activity.

After obtaining clearance from the Contracting Officer, the Contractor shall proceed with excavating work, or other surface penetration work. Contractor, however, shall temporarily halt any machine excavation work or other surface penetration when approaching within 10 feet of the staked-out cable or pipe line until the Contractor has exposed the cable or pipe by hand excavation to fix its location.

1.13 GAS PROTECTION

Contractor shall have one or more employees properly trained in operation of gas testing equipment and formally qualified as gas inspectors who shall be on duty during times workmen are in confined spaces. Their primary functions shall be to test for gas and operate testing equipment. Unless equipment of constant supervisory type with automatic alarm is employed, gas tests shall be made at least every 2 hours or more often when character of ground or experience indicates gas may be encountered. A gas test shall be made before workmen are permitted to enter the excavation after an idle period exceeding one-half hour.

Readings shall be permanently recorded daily, indicating the concentration of gas, number and location of drilled piers, point of test, date, and time of test.

Special requirements, coordination, and precautions will apply to areas that contain a hazardous atmosphere or, by virtue of their use or physical character, may be oxygen deficient. A check by Government is required prior to entering confined space. Surveillance and monitoring shall be required in these types of work spaces by both Contractor and Government

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personnel.

1.14 WELDING, FLAME CUTTING, AND MELTING

Contractor shall clear welding and cutting operations with the Contracting Officer before operations begin.

Contractor shall discontinue burning, welding, or cutting operations 1 hour prior to the end of the normal work day. A workman shall remain at the site for 1 hour after discontinuing these operations to make thorough inspection of the area for possible sources of latent combustion. He shall be equipped with two full 15-pound carbon dioxide fire extinguishers. Any unsafe conditions shall be reported to the Safety Branch. (Telephone: (216) 433-2088)

During operations involving possible fire hazard, the Contractor shall notify the Contracting Officer and not proceed until clearance is obtained in writing. Contracting Officer may request a standby from the Safety Branch. This requirement does not relieve the Contractor of his responsibility for welding and cutting safety.

1.15 HIGH NOISE LEVEL PROTECTION

Operations performed by the Contractor that involve the use of equipment with output of high noise levels (jackhammers, air compressors, and explosive device activated tools) shall be scheduled for after duty working hours during the hours 4 PM to 12 AM. Use of any such equipment shall be approved in writing by the Contracting Officer prior to commencement of work.

1.16 SEVERE STORM PLAN

In the event of a severe storm warning, the Contractor shall:

- a. Secure outside equipment and materials and place materials possible to damage in protected locations.
- b. Check surrounding area, including roof, for loose material, equipment, debris, and other objects that could be blown away or against existing facilities.
- c. Ensure that temporary erosion controls are adequate.

1.17 HAZARDOUS WASTE

Contractor shall identify all wastes produced and dispose of them in the following approved manners:

Identify all wastes and waste producing processes including chemicals, paints, POL products and solvents, and their containers. Unknown wastes will be chemically identified by the Government.

Obtain a determination of whether the waste is hazardous from the Contracting Officer.

Notify the Contracting Officer prior to taking disposal action for any hazardous waste.

For disposal, provide either laboratory analysis data documenting the

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chemical content of the waste or certification by appropriate organization authority as to the chemical constituents of the waste. Technical assistance on disposal analysis requirements will be provided on request by contacting the Contracting Officer.

Document the waste type, quantity, location, and personnel/contractor/agency responsible so the material can be tracked from generation through ultimate disposal as required by Environmental Protection Agency under Resource Conservation and Recovery Act.

1.18 CONFINED SPACE

Comply with the requirements in Chapter 16 of the GRC Safety Manual, 29 CFR 1910.146 and NHS/IHS 1845.2. Any potential for a hazard in the confined space requires a permit system to be used. NHS/IHS 1845.2 is available on the internet at

- a. Entry Procedures. Prohibit entry into a confined space by personnel for any purpose, including hot work, until the qualified person has conducted appropriate tests to ensure the confined or enclosed space is safe for the work intended and that all potential hazards are controlled or eliminated and documented. All hazards pertaining to the space shall be reviewed with each employee during review of the AHA.
- b. Forced air ventilation is required for all confined space entry operations and the minimum air exchange requirements must be maintained.
- c. Ensure the use of rescue and retrieval devices in confined spaces greater than 5 feet in depth.
- d. Manholes and excavations require continuous atmosphere monitoring with audible alarm for toxic gas detection and low oxygen levels.
- e. Include training information for employees who will be involved as entrant attendants for the work.
- f. Entry Permit. Use C-199 , completed by the qualified person. Post the permit in a conspicuous place close to the confined space entrance.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

-- End of Section --

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SECTION 01 35 43.98

ENVIRONMENTAL PROTECTION PROCEDURES

04/06

PART 1 GENERAL

1.1 SUMMARY

The pollution prevention, environmental compliance, and sustainability provisions described in this section apply to all work under this contract.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.120	(2002) Hazardous Waste Operations and Emergency Response
29 CFR 1910.1200	(1996) Hazard Communication
29 CFR 1910	Occupational Safety and Health Standards
40 CFR 82	Protection of Stratospheric Ozone
40 CFR 112	(2005) Subpart B Requirements for Petroleum Oils and Non-Petroleum Oils
40 CFR 261	(2005) Identification and Lists of Hazardous Wastes
40 CFR 262	Standards Applicable to Generators of Hazardous Waste
40 CFR 265.16	(2003) Personnel Training
40 CFR 273.2	(2003) Batteries
40 CFR 273.3	(2003) Pesticides
40 CFR 273.4	(2003) Mercury Thermometers
40 CFR 273.5	(2003) Lamps
40 CFR 173	(2005) Shippers -- general requirements for shipments and packagings
40 CFR 177	(2005) Carriage by public highway
40 CFR 178	(2005) Specifications for packagings
40 CFR 761	(2005) Polychlorinated biphenyls (PCBs) manufacturing, processing, distribution in

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commerce, and use prohibitions

49 CFR 100-185

(2002) Transportation

49 CFR 171

General Information, Regulations, and Definitions

50 CFR 17

(2002) Endangered and Threatened Wildlife and Plants

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01 33 00, "SUBMITTAL PROCEDURES," in sufficient detail to show full compliance with the specification:

SD-01 Preconstruction Submittals

Environmental protection plan

Dirt and dust control plan

Hazardous Materials Inventories Statement (HMIS) and Material Safety Data Sheets (MSDS), at project commencement and as necessary to reflect changes in materials stored.

A copy of the Hazard Communication Written Program per 29 CFR 1910.1200(e).

MSDSs of all products before bringing these materials on-site.

List of Solid Waste, Hazardous Waste, Construction Debris (CD) and Commercial/Industrial Fill (CIF) Subcontractors four weeks prior to removal from site.

Storm Water Pollution Prevention Plan. See section 01 57 23.98.

Treatment, Storage and Disposal Facility List: The Contractor shall submit a list of storage and disposal facilities (TSDF) that perform treatment, storage, or disposal services under this contract. Each facility shall have, as a minimum, EPA RCRA interim status or state approval as a treatment of disposal facility and be in good standing with regulatory community. Recycling facilities shall meet all federal, state and local regulations. The Contractor shall not use a facility other than those initially approved for use under this contract without first obtaining the written approval of the COTR.

SD-06 Test Reports

Site Inspection Checklists, every week for projects handling hazardous materials.

RCRA 90-Day Waste Accumulation Site Inspection Checklists, weekly for all hazardous waste storage areas for the duration of the on-site project work.

Hazardous Waste Profiles, and supporting analytical data three weeks prior to disposal for NASA GRC Waste Management Team (WMT)

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to review prior to Environmental Management Branch (EMB) signature.

Laboratory analysis

Disposal Requirements

SD-07 Certificates

TSDF Letter of Acceptance and Hazardous Waste Manifests one week prior to shipment and for review by WMT and signature by NASA GRC Environmental Management Branch immediately prior to shipment.

Final, signed hazardous waste manifests completed by the contractor and disposal facility in accordance with 40 CFR 261. The NASA Waste Management Team shall receive the final signed manifest directly from the disposal facility. In the event the contractor receives the final signed manifest, it shall be immediately forwarded to the NASA Waste Management Team. For Solid Waste/CD/CIF all documents shall be forwarded to the Contracting Officer by the Contractor.

SD-11 Closeout Submittals

Some of the records listed below are also required as part of other submittals. For the "Records" submittal, maintain on-site a separate three-ring Environmental Records binder and submit at the completion of the project. Make separate parts to the binder corresponding to each of the applicable sub items listed below.

Preconstruction survey

Waste determination documentation

Disposal documentation for solid, hazardous, and regulated waste

Contractor employee training records in compliance with 40 CFR 265.16, 29 CFR 1910.120, 29 CFR 1910.1200 and 40 CFR 82.

Regulatory notification

Erosion and sediment control inspection reports

Solid waste disposal report

Contractor Hazardous Material Inventory Log

Hazardous Waste/Debris Management

Reclamation of Equipment Containing Hazardous Waste Residues: The Contractor shall submit to the COTR the facility to which equipment containing hazardous material residues are shipped for reclamation, such as electrical wrapped with asbestos and electrical panels containing asbestos. The disclosure shall be documented on the Bill of Lading or by other written means. This process shall be managed by the WMT.

Disposal of Non-Hazardous Waste Containing Hazardous Material Residue: The Contractor shall submit to the COTR the facility to which equipment containing hazardous material residues are shipped

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for disposal, such as steel coated with lead paint. The disclosure shall be documented on the Bill of Lading or by other written means. Supporting analytical data shall be included to document the equipment is not hazardous waste.

1.4 GENERAL RESPONSIBILITIES

Conduct project activities in a manner that protects surface/ground water and air quality, conserves resources, and minimizes the use of toxic chemicals and hazardous materials.

Minimize environmental pollution and damage that may occur as the result of construction and demolition operations. The environmental resources within the project boundaries and those affected outside the limits of permanent work shall be protected during the entire duration of this contract.

The Contracting Officer will notify the Contractor in writing of any observed noncompliance with Federal, State, or local environmental laws or regulations, permits, GRC Environmental Policy, and Federal Executive Orders. The Contractor shall, after receipt of such notice, inform the Contracting Officer of the proposed corrective action and take such action when approved by the Contracting Officer in consultation with the Environmental Management Branch. The Contracting Officer may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No time extension shall be granted or equitable adjustments allowed to the Contractor for any such suspensions. This is in addition to any other actions the Contracting Officer may take under the contract, or in accordance with the Federal Acquisition Regulation of Federal Law.

The Contractor shall be responsible for payment of all fines/fees for violation or non-compliance with Federal, State, Regional and local environmental laws and regulations.

1.5 CONSTRUCTION AND DEMOLITION DEBRIS (C&DD) MANAGEMENT

Any removed or demolished item that meets the definition of C&DD shall be evaluated for reuse and/or recycling. The Contractor shall reuse or recycle any item that can be segregated from the waste stream and reused or recycled in a cost effective manner. The WMT manages the Construction Waste Management Program. All reuse, recycling and disposal activities shall be coordinated with the WMT. The Contractor shall submit a manifest for any C&DD materials that will be reused off site, recycled or disposed of to the COTR, which will then be reviewed and approved by the WMT for transportation off-site. Materials that will be reused or recycled shall be segregated and manifested individually. NASA has specifically targeted the following materials for reuse or recycling: Asphalt, Concrete, Gravel/Stone, Commercial/Industrial Fill Soil, Topsoil, Trees/Bushes, Ferrous and Non-Ferrous Metals, Concrete Block, Bricks, Carpeting, and Ceramic Tiles.

1.6 DEFINITIONS

Construction and Demolition Debris - Those materials resulting from the alteration, construction, destruction, rehabilitation, or repair of any manmade physical structure, including, without limitation, houses, buildings, industrial or commercial facilities, or roadways. "Construction and demolition debris" does not include materials identified or listed as solid wastes, infectious wastes, or hazardous wastes pursuant to Chapter

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3734 of the Revised Code and rules adopted under it; or materials from mining operations, nontoxic fly ash, spent nontoxic foundry sand, and slag; or reinforced or non-reinforced concrete, asphalt, building or paving brick, or building or paving stone that is stored for a period of less than two years for recycling into a usable construction material. For the purpose of this definition, "materials resulting from the alteration, construction, destruction, rehabilitation, or repair of any manmade physical structure," are those structural and functional materials comprising the structure and surrounding site improvements, such as brick, concrete and other masonry materials, stone, glass, wall coverings, plaster, drywall, framing and finishing lumber, roofing materials, plumbing fixtures, heating equipment, electrical wiring and components containing no hazardous fluids or refrigerants, insulation, affixed carpeting, asphalt substances, metals incidental to any of the above, and weathered railroad ties and utility poles. "Materials resulting from the alteration, construction, destruction, rehabilitation, or repair" do not include materials whose removal has been required prior to demolition, and materials which are otherwise contained within or exist outside the structure such as solid wastes, yard wastes, furniture, and appliances. Also excluded in all cases are liquids including containerized or bulk liquids, fuel tanks, drums and other closed or filled containers, tires, and batteries.

"Clean hard fill" - C&DD which consists only of reinforced or non-reinforced concrete, asphalt concrete, brick, block, tile, and/or stone which can be reutilized as construction material. Brick in clean hard fill includes but is not limited to refractory brick and mortar. Clean hard fill does not include materials contaminated with solid wastes, hazardous wastes, or infectious wastes.

Hazardous Material - Any material that poses a significant present or potential hazard to human health and safety or to the environment if released into the workplace or the environment. Common examples are oil, fuel, caustic and acid cleaners, mineral spirits, petroleum distillate based solvents, oil based paints, aerosol spray paints, coolants and antifreeze, and solvents/cleaners containing chlorinated compounds.

Hazardous Waste - As defined in [40 CFR 261.3](#).

Non-Hazardous Solid Waste - Includes rubbish, debris, garbage, and other discarded solid materials resulting from industrial, commercial, construction, and agricultural operations, and from community activities. Also includes soil with contaminant levels above Voluntary Action Program (VAP) commercial/industrial fill standards.

Non-Sewerable - Wastewater that contains at least one contaminant above the allowable discharge limit set by the Publicly Owned Treatment Works (POTWs) for discharge to the sanitary sewer.

Reclamation - A process to recover or regenerate a usable product. Examples are recovery of lead from spent batteries and regeneration of spent solvents.

Recycling - In general, the use of discarded materials and objects in original or changed form rather than disposing of them. Examples include paper, cardboard boxes, empty containers and certain elements of Construction and Demolition Debris, including but not limited to metal building materials, piping, electrical, wiring, concrete, and masonry building materials, gypsum products and various floor coverings.

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Solid Waste - As defined in 40 CFR 261.2.

Surface Discharge - implies that the water is discharged with possible sheeting action and subsequent soil erosion may occur. Waters that are surface discharged may terminate in drainage ditches, storm sewers, creeks, and/or "waters of the United States" and may require a permit to discharge water from the State of Ohio.

Universal Waste - Universal Waste means any of the following hazardous wastes that are subject to the universal waste requirements of 40 CFR part 273:

- (1) Batteries as described in 40 CFR 273.2
- (2) Pesticides as described in 40 CFR 273.3
- (3) Thermostats as described in 40 CFR 273.4; and
- (4) Lamps as described in 40 CFR 273.5.

1.7 NATURAL AND CULTURAL RESOURCES

The Contractor shall conduct activities in a manner that does not unnecessarily negatively impact fauna or flora, and in accordance with 50 CFR 17. The Contractor shall minimize interference with, disturbance to, and damage to all fish, wildlife, and plants including their habitat. The Contractor shall be responsible for the protection of threatened and endangered animal and plant species including their habitat in accordance with Federal, State, and local laws and regulations.

If during excavation or other construction activities any previously unidentified or unanticipated historical, archaeological, and cultural resources are discovered or found, all activities that may damage or alter such resources shall be temporarily suspended. Resources covered by this paragraph include but are not limited to any human skeletal remains or burials, artifacts, shell, midden (refuse heap), bone, charcoal, or other deposits, rock or coral alignments, pavings, wall, or other constructed features, and any indication of agricultural or other human activities. Upon such discovery or find, the Contractor shall immediately notify the Contracting Officer so that the appropriate authorities may be notified and a determination made as to their significance. The Contractor shall cease all activities that may result in impact to or the destruction of these resources. The Contractor shall secure the area and prevent employees or other persons from trespassing on, removing, or otherwise disturbing such resources. The Contractor may proceed with work in areas devoid of cultural resources.

1.8 WASTEWATER DISCHARGE PERMITS

In accordance with the Clean Water Act and State of Ohio regulations, a specific Incidental Sewer Discharge permit is required before discharging wastewaters to the sanitary sewer system from project activities such as excavation dewatering, cleaning operations, and decontamination water.

The Contractor shall complete and submit a Request for Incidental Sewer Discharge form to the Contracting Officer at least 7 days prior to the planned discharge of contaminated groundwater or other wastewater. The Contracting Officer will inform the GRC Environmental Management Branch (EMB) of this request and obtain approval for discharge. The request shall include the estimated discharge volume, discharge rate, source of the wastewater and the duration of discharge. Analyses may be needed to obtain

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discharge approval from EMB.

1.8.1 Wastewater Discharge

With the exception of non-contaminated groundwater from an excavation, wastewater from Contractor operations shall be containerized by the Contractor until the Contractor is notified of discharge approval.

The Contractor shall record and submit information specified in the discharge permit issued to the project including, but not limited to, the location of discharge, dates of discharge, quantity of water discharged, source of the wastewater, dates wastewater was sampled and analyzed (if required), and filtering method (if required).

Non-sewerable wastewater that is hazardous waste shall be managed and disposed of properly by the Contractor. Non-sewerable wastewater that is nonhazardous waste shall be treated, managed, and disposed of properly by the Contractor.

1.9 AIR QUALITY

Construction operations and materials used on the project shall be in compliance with federal, state, and local air pollution standards, rules and regulations.

Chlorofluorocarbons (CFCs), Hydrochlorofluorocarbon (HCFC), Other Ozone Depleting Substances (ODS) and their substitutes.

Class I Ozone Depleting Substances shall not be used in the performance of this contract, nor be provided as part of the equipment without prior written permission from the Environmental Management Branch. This prohibition shall prevail over any other provision, specification, drawing, or referenced documents. A list of Class I ODS may be obtained from US EPA or their web page at <http://www.epa.gov/ozone/ods.html>.

Class II Ozone Depleting Substances shall not be used in the performance of this contract, nor be provided as part of the equipment without prior written permission from the Environmental Management Branch. This prohibition shall prevail over any other provision, specification, drawing, or referenced documents. A list of Class II ODS may be obtained from US EPA or their web page at <http://www.epa.gov/ozone/ods2.html>.

Chemicals used in lieu of ozone depleting substances (Substitutes or alternatives) must conform with US EPA's Significant New Alternatives Policy (SNAP) program. These rules are summarized on the US EPA web page at <http://www.epa.gov/ozone/snap/lists/index.html>.

Service, maintain, renovate, and demolish ODS and ODS Substitute containing equipment in accordance with 40 CFR 82. The Contractor shall ensure that ODS refrigerants and their substitutes are handled by a certified technician. The recovery equipment shall meet applicable EPA requirements and be certified with US EPA.

Hazardous Air Pollutants (HAPs).

The list of specific chemicals and compounds defined as HAPs in Section 112b of the 1990 Clean Air Act Amendments is available from Ohio EPA

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on-line at: <http://www.epa.state.oh.us/dapc/general/haplist.html>. This listing is subject to change and only the currently listed items require tracking.

The use of HAPs and materials containing HAPs is allowed at GRC however the airborne release of HAPs shall be minimized at all times.

Records of the use of HAPs and materials containing HAPs must be provided to the CO for forwarding to the Environmental Management Branch. At a minimum, this should include Material Safety Data Sheets and quantities of each HAP and materials containing HAPs used.

Product and waste HAPs and materials containing HAPs must be stored in such a way as to prevent their release to the atmosphere.

Prohibition of Air Pollution Nuisances

No air pollution generating activity shall be allowed if it is expected to cause an air pollution nuisance.

No air pollution generating activity shall be allowed to continue if it is found to be an air pollution nuisance.

1.10 HAZARDOUS WASTE LIABILITY

Hazardous Waste Liability - For the purpose of this contract, the Contractor shall be responsible for any release or threatened release of the materials or substances handled under this contract, as well as any liabilities resulting or arising from or related to this contract, and shall bear all costs pertaining to such releases including, but not limited to, responses, remediation, testing, or disposal costs, and further shall defend and indemnify the Government for any costs including, but not limited to, any judgments, penalties, assessments, litigation, or attorney fees.

1.11 HAZARDOUS WASTE TRANSPORTATION

Certified Waste Haulers shall be utilized. Government directed waste shall be transported to the disposal facility or interim storage facility without delay, in accordance with Department of Transportation (DOT) manifest regulations. The Contractor shall notify the Government if 10 days or more have elapsed during shipment.

1.12 SUSTAINABILITY

The Contractor shall conduct its activities in a manner that conserves resources and minimizes pollution in accordance with Executive Order 13101 "Greening the Government Through Waste Prevention, Recycling and Federal Acquisition" and Executive Order 13123 "Greening the Government Through Efficient Energy Management".

Minimize the amount of energy required during construction and operation by using resource efficient construction techniques, building systems (including HVAC, heating, electrical, water, lighting, heat-pumps and boilers), insulation, fixtures, appliances, and controls.

Whenever possible, utilize energy efficient office equipment through the Environmental Protection Agency's Energy Star labeling program (@

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<http://www.epa.gov/energystar/>).

Use automated monitors and controls for energy, water, waste, temperature, moisture, and ventilation.

Conserve water with systems that reduce consumption and recycle water through reclamation and treatment systems.

Maximize the reduction, reuse, recycling or composting of waste and scrap materials.

Minimize waste, spillage, pilferage, spoil, and misuse of building materials.

Follow federal Comprehensive Procurement Guidelines (@ <http://www.epa.gov/epaoswer/non-hw/procure/>) for building materials and products, and select materials that have a long-life cycle; select least toxic materials; select recyclable materials; select materials that are resource-efficient; select materials with the maximum recycled content; select materials harvested on a sustained yield basis; select products causing the least pollution during their manufacture, use and reuse.

1.13 TRAINING REQUIREMENTS

Personnel handling hazardous materials shall have received Hazard Communication Training per 29 CFR 1910.1200(h), and personnel handling hazardous waste shall have received appropriate DOT and Hazardous Waste and Emergency Response Operations (HAZWOPER) Emergency Response Awareness Level Training per 29 CFR 1910.120. Employee training documents shall be kept at the jobsite.

Personnel containing spills or conducting cleanup of small spills shall have received First Responder Operators level training per 29 CFR 1910.120. (Note: Personnel with First Responder Operators level training can contain a spill to stop its spread from a safe distance. Their function is to contain the release from a safe distance, keep it from spreading, and prevent exposures.

Personnel generating hazardous waste shall have receive training on the proper management of hazardous waste per 40 CFR 265.16.

Personnel Handling Refrigerants shall have training in accordance with 40 CFR 82.

1.14 CHEMICAL USGAE, STORAGE, AND HANDLING

Hazardous material shall be used only as described on the Material Safety Data Sheet and/or Contractor's written instructions. The Contractor shall wear the protective equipment recommended by the manufacturer of the hazardous material. Containers of hazardous materials and hazardous wastes shall be kept closed except when in use. Containers of liquid hazardous materials shall be stored in secondary containment at the end of each work shift.

1.14.1 Hazardous Materials Storage

Hazardous materials storage shall be in accordance with Federal, State, and local regulations, and the General Storm Water Permit. Hazardous materials

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shall be handled in a manner that minimizes the potential for releases. All liquid hazardous materials must be secondarily contained. Adequate spill response equipment shall be readily available.

Hazardous materials and hazardous wastes shall be labeled, handled properly, and stored in secondary containment at the end of each work day. Secondary containment shall be of adequate size and compatible with the materials stored. Storage areas shall be properly labeled and secured. Storage areas shall be in accordance with Section 01 57 23.98, Storm Water Pollution Prevention.

At the beginning of the project, an accurate inventory of hazardous materials and hazardous wastes to be generated including the estimated maximum quantity of each hazardous material to be brought on-site shall be provided to the COTR. Material Safety Data Sheets (MSDSs) for hazardous materials shall be maintained by the Contractor so they are immediately available to assist emergency response personnel in the event of a hazardous materials incident. Copies of the MSDSs shall be provided in the Health and Safety Plan (HASP).

1.14.2 Refuse Bins

Refuse bins shall not be overloaded. Liquid materials shall not be placed in dumpsters or bins. Leaking dumpsters shall be replaced. Dumpsters and bins shall not be cleaned on-site. Dumpsters shall remain covered except when actively being loaded.

1.14.3 Site Inspections

The project site and storage areas shall be inspected weekly to ensure compliance. Compliance status shall be verified by the Contractor. The checklists shall be submitted to the COTR, within 48 hours following the inspection.

1.14.4 Labeling

Containers, drums, vessels, tanks, and associated piping containing hazardous materials shall be labeled in accordance with 29 CFR 1910.1200 (f).

Hazardous material labels must have a description of the contents (including percentages of components for compounds), an appropriate hazard warning and the name and address of the manufacturer or other responsible party.

Hazardous waste and solid waste containers shall be appropriately marked, pending analysis, in accordance with 40 CFR 262 with, at a minimum, accumulation start date and contents and documented during weekly inspections.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 SITE OPERATIONS AND MAINTENANCE

Site Operations shall be conducted in accordance with the Clean Water Act

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and GRC Storm Water Pollution Prevention Plan. For projects over 1 acre (total) in size, a Storm Water Pollution Prevention Plan must be submitted to the GRC Environmental Management Branch 2 months prior to project commencement for review and approval. (See Storm Water Pollution Prevention Section 01 57 23.98.)

Equipment Fueling and Maintenance - Equipment fluid changes and fueling shall be conducted over drip pans to prevent spilled materials from contacting the ground surface. The operator of leaking equipment shall contain and control the leak. The Contractor shall contact the EMB Waste Management Team through the Contracting Officer to coordinate proper disposal of waste materials generated during equipment maintenance.

3.1.1 Paint Clean-up

Painting operations must be conducted in accordance with GRC Storm Water Pollution Prevention Plan and applicable State of Ohio requirements.

Water Based Paints:

The Contractor shall paint out as much excess paint as possible from brushes, rollers, and equipment before starting clean up. Rinse brushes, rollers, and other tools over a sink that drains to the sanitary sewer using water only. Tools and equipment shall not be cleaned into streets, gutters, storm drains, or creeks. Dispose of dry brushes, rollers, rags, and drop cloths as solid waste.

Disposal of containers with any liquids as a solid waste is prohibited. These materials must be used elsewhere or handled as a hazardous waste and disposed of in accordance with paragraph entitled Contractor Disposal.

Oil Based Paints:

The Contractor shall paint out as much excess paint as possible from brushes, rollers, and equipment before starting clean up. Cleaning wash water shall be containerized and disposed of as hazardous waste. Reuse thinners and solvents by pouring back into original container through a filter.

Dispose of waste thinners, solvents, paint sludge, and wash water from cleaning of equipment and tools as hazardous waste. Containers with residual product shall be managed as a hazardous waste and disposed of.

3.1.2 Concrete/Asphalt Cutting and Core Drilling

The Contractor shall prevent not allow slurry run-off from saw cutting or core drilling to enter the storm or sanitary sewer collection systems. Catch basins and drains shall be protected.

3.1.3 Sweeping

Roadways and on-site paved areas impacted by the project shall be cleaned to the satisfaction of the COTR and swept at the end of each phase or at project completion. Hosing down paved areas and streets is prohibited.

3.1.4 Sewage Sludge

Sewage Sludge and Compost Materials containing human waste is prohibited

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from use at GRC.

3.1.5 Draining, Tanks, Piping, and Equipment

Tanks, piping, and equipment shall be drained as required. Devices to properly contain the product shall be provided by the Contractor. Storm drains in the vicinity shall be covered during drainage operations.

The Government will obtain the necessary sanitary sewer discharge permits if the discharge is sewerable. Non-sewerable water shall be treated to a level to allow discharge to the sanitary sewer or managed and disposed of properly by the Government.

3.1.6 Monitoring Wells

Monitoring Wells shall not be disturbed for any reason. If they are disturbed, inadvertently or not, the contractor shall incur all costs associated with the abandonment (i.e. removal) of the well in accordance with Ohio EPA requirements.

3.2 CONTAMINATED SOIL MANAGEMENT

The Contractor shall immediately stop work and notify the COTR if soil appears discolored or has an odor different from what is expected.

3.3 PCBs/PCB CONTAMINATED EQUIPMENT

All PCB-contaminated material shall be handled in accordance with 40 CFR 761.

The Contractor shall dial 911 from any NASA phone or 216-433-8888 from an outside phone to inform Emergency Dispatch of any spills or leaks of PCB-contaminated material.

The contractor shall notify the Contracting Officer of any PCB-contaminated material that needs disposal.

3.4 SPILL PREVENTION, CONTROL AND REPORTING

All liquid petroleum products must be secondarily contained in accordance with Annex Q of GRC's Emergency Preparedness Plan and 40 CFR 112. Spill clean-up materials (such as rags, absorbent booms/pads), and tools (such as shovels and brooms) shall be maintained at the project site and be readily accessible. Releases of hazardous materials to the environment shall be contained and measures implemented to prevent leaks and spills from entering storm drains.

Dial 911 from any NASA phone or 216-433-8888 from an outside phone to inform Emergency Dispatch of any spills or leaks

3.5 HAZARDOUS WASTE DISPOSAL

The Contractor shall label, package, and secondarily contain hazardous waste in accordance with 49 CFR 171, 40 CFR 173, 40 CFR 177, and 40 CFR 178.

Storage of hazardous waste shall not exceed 90 days from the date of generation in accordance with 40 CFR 262. Hazardous waste shall be shipped for disposal no later than 90 days from the date of generation/accumulation start date.

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No hazardous material or waste shall remain at the worksite upon completion of the project unless specified otherwise.

3.5.1 Hazardous Waste Manifest

NASA Glenn Research Center shall be designated as the generator on the manifest and only approved GRC Environmental Management Branch personnel shall sign any shipping documents, including Uniform Hazardous Waste Manifests.

NASA Glenn Research Center Environmental Management Branch shall be designated as the emergency contact.

The Contractor shall perform transportation services in compliance with 49 CFR 100-185.

The Contractor shall use only disposal facilities that have a valid permit to manage hazardous waste, and shall be responsible for determining that permit allows for the type of management and disposal intended for that waste. The Contractor shall be responsible for ensuring that any party handling hazardous waste, including subcontractors, transporters, and TSDFs are in compliance with applicable federal, state, and local regulations. GRC EMB shall have final approval of TSDFs.

3.5.2 Containerized Hazardous Waste

Hazardous wastes and other materials shipped by the Contractor with wastes from other facilities shall not be commingled.

3.5.3 Bulk Hazardous Waste

Bulk hazardous waste shipments shall be weighed to confirm shipping weight.

3.5.4 Miscellaneous Hazardous Waste

Fluorescent light tubes, mercury containing and PCB lighting ballasts and thermostats shall be turned over to the Government for recycling.

-- End of Section --

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REFERENCES

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PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

Reference publications are cited in other sections of the specifications along with identification of their sponsoring organizations. The addresses of the sponsoring organizations are listed below, and if the source of the publications is different from the address of the sponsoring organization, that information is also provided.

ACI INTERNATIONAL (ACI)
P.O. Box 9094
Farmington Hills, MI 48333-9094
Ph: 248-848-3700
Fax: 248-848-3701
Internet: <http://www.aci-int.inter.net>

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)
444 N. Capital St., NW, Suite 249
Washington, DC 20001
Ph: 800-231-3475 or 202-624-5800
Fax: 800-525-5562 or 202-624-5806
Internet: www.aashto.org

AMERICAN CONCRETE PIPE ASSOCIATION (ACPA)
222 West Las Colinas Blvd., Suite 641
Irving, TX 75039-5423
Ph: 972-506-7616
Fax: 972-506-7682
Internet: <http://www.concrete-pipe.org>
e-mail: info@concrete-pipe.org

AMERICAN HARDBOARD ASSOCIATION (AHA)
1210 W. Northwest Highway
Palatine, IL 60067
Ph: 708-934-8800
Fax: 708-934-8803

AMERICAN PETROLEUM INSTITUTE (API)
1220 L St., NW
Washington, DC 20005-4070
Ph: 202-682-8000
Fax: 202-962-4776
Internet: <http://www.api.org>

AMERICAN RAILWAY ENGINEERING AND MAINTENANCE-OF-WAY ASSOCIATION (AREMA)
8201 Corporate Dr., Suite 1125

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Landover, MD 20785
Ph: 301-459-3200
Fax: 301-459-8077

AMERICAN WATER WORKS ASSOCIATION (AWWA)
6666 West Quincy
Denver, CO 80235
Ph: 800-926-7337
Fax: 303-795-2114
Internet: www.awwa.org

AMERICAN WELDING SOCIETY (AWS)
550 N.W. LeJeune Road
Miami, FL 33126
Ph: 800-443-9353
Fax: 305-443-7559
Internet: www.amweld.org

AMERICAN WOOD-PRESERVERS' ASSOCIATION (AWPA)
3246 Fall Creek Highway, Suite 1900
Grandbury, TX 76049-7979
Ph: 817-326-6300
Fax: 817-326-6306

APA - THE ENGINEERED WOOD ASSOCIATION (APA)
P.O.Box 11700
Tacoma, WA 98411-0700
Ph: 253-565-6600
Fax: 253-565-7265
Internet: <http://www.apawood.org>

ASME INTERNATIONAL (ASME)
Three Park Avenue
New York, NY 10016-5990
Ph: 212-591-7722
Fax: 212-591-7674
Internet: www.asme.org

ASPHALT INSTITUTE (AI)
Research Park Dr.
P.O. Box 14052
Lexington, KY 40512-4052
Ph: 606-288-4960
Fax: 606-288-4999
Internet: www.asphaltinstitute.org
e-mail: asphalti@asphaltinstitute.org

ASTM INTERNATIONAL (ASTM)
100 Barr Harbor Drive
West Conshohocken, PA 19428-2959
Ph: 610-832-9500
Fax: 610-832-9555
Internet: www.astm.org

CONCRETE REINFORCING STEEL INSTITUTE (CRSI)
933 No. Plum Grove Rd.
Schaumburg, IL 60173-4758
Ph: 847-517-1200
Fax: 847-517-1206

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Internet: <http://www.crsi.org>

DUCTILE IRON PIPE RESEARCH ASSOCIATION (DIPRA)
245 Riverchase Parkway East, Suite 0
Birmingham, AL 35244-1856
Ph: 205-402-8700
Fax: 205-402-8730
Internet: www.diprn.org

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)
445 Hoes Ln, P. O. Box 1331
Piscataway, NJ 08855-1331
Ph: 732-981-0060 OR 800-701-4333
Fax: 732-981-9667
Internet: <http://www.standards.ieee.org>
E-mail: customer.service@ieee.org

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS
INDUSTRY (MSS)
127 Park St., NE
Vienna, VA 22180-4602
Ph: 703-281-6613
Fax: 703-281-6671
Internet: [//cssinfo.com/info/mss/html](http://cssinfo.com/info/mss/html)

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)
Publication(s) Available From
Superintendent of Documents
U.S. Government Printing Office
Washington, DC 20402
Ph: 202-783-3238

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)
1300 N. 17th St., Suite 1847
Rosslyn, VA 22209
Ph: 703-841-3200
Fax: 202-841-3300
Internet: <http://www.nema.org/>

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)
One Batterymarch Park
P.O. Box 9101
Quincy, MA 02269-9101
Ph: 800-344-3555
Fax: 800-593-6372
Internet: <http://www.nfpa.org>

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)
Department of Commerce
Gaithersburg, MD 20899-0001
Ph: 301-975-4025
Fax: 301-926-1630
Order From:
Superintendent of Documents
U.S. Government Printing Office (GPO)
Washington, DC 20402
Ph: 202-512-1800
Fax: 202-512-2250
or

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National Technical Information Services (NTIS)
5285 Port Royal Rd.
Springfield, VA 22161
Ph: 800-553-6847
Fax: 703-321-8547
Internet: <http://www.gov/ntis.gov>

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)
40 24th Street, 6th Floor
Pittsburgh, PA 15222-4656
Ph: 412-281-2331
Fax: 412-281-9992
Internet: www.sspc.org

UNDERWRITERS LABORATORIES (UL)
333 Pfingsten Rd.
Northbrook, IL 60062-2096
Ph: 847-272-8800
Fax: 847-272-8129
Internet: <http://www.ul.com/>
Order from:
Global Engineering Documents
15 Inverness Way East
Englewood, CO 80112-5776
Ph: 800-569-7128
Fax: 303-397-7945
Internet: <http://global.ihs.com>
E-mail: global@ihs.com

UNI-BELL PVC PIPE ASSOCIATION (UBPPA)
2655 Villa Creek Dr., Suite 155
Dallas, TX 75234
Ph: 214-243-3902
Fax: 214-243-3907

U.S. DEPARTMENT OF COMMERCE (DOC)
Order From:
National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Ph: 703-605-6000
Fax: 703-605-6900
Internet: <http://www.ntis.gov>

U.S. FEDERAL AVIATION ADMINISTRATION (FAA)
Order for sale documents from:
Superintendent of Documents
P.O. Box 371954
Pittsburgh, PA 15250-7954
PH: 202-512-1800 (order desk)
Internet: <http://www.gpo.gov>
Order free documents from:
Federal Aviation Administration
Dept. of Transportation
Ardmore East Business Center
33410 75th Avenue
Landover, MD 20785
Ph:
FAX: 301-386-5394

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Internet: <http://www.faa.gov>

U.S. GENERAL SERVICES ADMINISTRATION (GSA)
General Services Administration
1800 F Street, NW
Washington, DC 20405
PH: 202-501-0705

Order from:
General Services Administration
Federal Supply Service Bureau
1941 Jefferson Davis Highway
Arlington, VA 22202
PH: 703-605-5400
Internet: <http://www.fss.gsa.gov/pub/fed-specs.cfm>

U. S. GREEN BUILDING COUNCIL (USGBC)
1015 18th Street NW, Suite 508
Washington, DC 20036
PH: 202-828-7422 Office
FAX: 202-828-5110
Internet: www.usgbc.org

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)
700 Pennsylvania Avenue, N.W.
Washington, D.C. 20408
Phone: 866-325-7208
Internet: <http://www.archives.gov>
Order documents from:
Superintendent of Documents
U.S. Government Printing Office
732 North Capitol Street, NW
Washington, DC 20401
Mailstop: SDE
Ph: 866-512-1800 or 202-512-1800
Fax: 202-512-2250
Internet: <http://www.gpo.gov>
E-mail: gpoaccess@gpo.gov

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SECTION 01 45 00.98

QUALITY CONTROL

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PART 1 GENERAL

1.1 SUMMARY

The requirements of this Section apply to, and are a component part of, each section of the specifications.

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-06 Test Reports

Contractor shall submit the following items in accordance with the paragraph entitled, "Records," of this section.

Quality Control Data
Quality Control Coordinating Actions
Quality Control Training
Inspection Records
Letters of Authority or Delegation
Field Tests
Factory Tests

SD-07 Certificates

Contractor shall submit a detailed written statement describing procedures that will be implemented to achieve quality on the project according to the paragraph entitled, "Quality Assurance (QA) Plan," of this section.

Contractor shall submit the following in accordance with the paragraph entitled, "Qualifications," of this section.

Contractor's Quality Representative Qualifications
Special Certifications

1.2.1 Quality Assurance (QA) Plan

QA plan shall address the following:

Description of the authority, responsibilities and coordinating procedures, of on-site/off-site quality assurance personnel, including those QA personnel not under direct control of the Contractor.

QA plan shall list personnel designated by the Contractor to accomplish the work required by the contract.

QA plan shall also contain an appendix with a copy of each form, report format, or similar record to be used in the QA program.

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Contractor's organization that handles construction contract activities.

Contractor's operational plan for accomplishing and reviewing work controls, fabrication controls, certifications, and documentation of quality control operations, inspections, and test records, including those for subcontractors.

These provisions shall include the methods to be used during the procurement cycle (order to delivery) for those materials or equipment that require source inspections, shop fabrications, or similar operations located separately from the work site.

Description of on-site personnel training.

Certification(s) of personnel, procedures, processes, and equipment.

Nondestructive testing requirements.

Identification of independent certifying and testing laboratories.

1.2.2 Records

Records shall include all [quality control data](#); [factory tests](#) or

manufacturer's certifications, [quality control coordinating actions](#); records of [quality control training](#)/certifications as well as routine hydrostatic, electrical continuity, grounding, welding, line cleaning, [field tests](#) and similar tests. Quality records shall be available for examination by the Contracting Officer.

Legible copies of the test and [inspection records](#) shall be furnished to the Contracting Officer. Records shall cover work placement traceable to the contract schedule, specifications and drawings, and shall be verified by the Contractor.

Contractor shall submit a monthly performance report that summarizes the quality operations. This report shall identify inspections made, tests performed, nonconformances, corrective actions taken, status of plans/procedures being developed, and status of open items/problems in work.

Contractor shall submit [Letters of Authority or Delegation](#) outlining the authority and responsibilities of quality control personnel along with a copy of the letter of delegation to the Contracting Officer that defines delegated duties and responsibilities.

In-process inspection records and control away from the job site may be used as evidence of quality of materials/work and may reduce further inspection or testing after delivery to the job site.

1.3 QUALITY ASSURANCE

1.3.1 Qualifications

[Contractor's Quality Representative Qualifications](#) shall be submitted to the Contracting Officer for approval. Quality Representative may be assigned to more than one contract provided that the assigned contracts are located at the same site.

When approval or certification of special processes, operating personnel,

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and special equipment or procedures is required by the specifications, the Contractor shall obtain necessary approvals or [special certifications](#) prior to starting the work.

1.3.2 Quality Control Requirements

Contractor shall provide a quality control program encompassing: selection of construction materials and sources; suppliers; subcontractors; on-site and off-site fabrication of Contractor-furnished assemblies; on-site and off-site assembly; erection; work procedures; workmanship; inspection; and testing.

Contractor's program shall provide document systems ensuring that quality provisions of contract schedule, specifications, and drawings have been performed.

1.3.2.1 Management and Organization

Contractor shall designate an individual within the on-site organization whose sole responsibility shall be the day-to-day on-site management and direction of the Quality Program.

The Quality Program Manager shall report to the Contractor's management and shall have the necessary authority to discharge contractual responsibilities.

1.3.2.2 Identification and Data Retrieval

Contractor shall have an identification and data retrieval system.

Records, drawings, submittals, and equipment shall be identified by referencing the Contract Number; Contract Specification Number; Contract Drawing Number; Submittal Document Number; Contract Change Number; and the Contractor's Drawing Number System.

1.3.2.3 Procurement

Contractor shall be responsible for controlling procurement sources and those of his subcontractors to ensure that each purchase meets quality requirements.

1.3.2.4 Receiving Inspection System

Contractor shall maintain a site receiving inspection system that ensures procured materials and equipment are inspected and tested.

Receiving inspection records shall accompany each procurement delivery to the construction site. Records of site receiving inspections shall be maintained by the Contractor.

Records shall show defects, discrepancies, dispositions, and waivers, including evidence of Government source inspection.

1.3.2.5 Nonconforming Articles and Material Control

The Contractor shall control nonconformances discovered by the Contractor, subcontractors, suppliers or Government quality representatives to prevent their use and to correct deficient operations.

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- a. Contractor shall prepare a "nonconformance" report for each instance comprising:
 - (1) A unique and traceable number.
 - (2) Identification of the nonconforming article or material.
 - (3) A description of the nonconformance and the applicable requirement.
 - (4) Cause or reason for the nonconformance.
 - (5) Remedial actions taken or recommended.
 - (6) Disposition of the nonconforming article or material.
- b. The Contractor shall identify and mark each nonconforming article for removal from the work area.
- c. The Contractor shall monitor and correct deficient operations.

1.3.2.6 Fabrication, Process, and Work Control

Contractor's procedures and controls shall ensure compliance with requirements in contract specifications and drawings.

Contractor shall establish in-process inspections, to ensure compliance with quality requirements.

Special processes may include, but are not limited to, plating, anodizing, nondestructive testing, welding, and soldering.

1.3.2.7 Quality Control Records

Quality control records shall be maintained at a central on-site location.

Maintenance of quality control records shall not relieve the Contractor from submitting samples, test data, detail drawings, material certificates, or other information required by each section in the specification.

Contractor shall ensure each record is identified and traceable to specific requirements in the specifications and drawings.

1.3.2.8 Drawings and Change Control

Drawing-control system shall be maintained to provide revised drawings and ensure continuous removal of obsolete drawings from work areas. Changes involving interface with other work areas, or affecting materials controlled by others shall be controlled by the Contractor. This system shall be integrated with the document requirements of the contract.

Drawing changes shall be clearly annotated. Implemented changes shall be clearly identified and associated drawings shall be revised accordingly. Drawings that have been approved, or approved as noted, by the Contracting Officer shall be used for fabrication and inspection.

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1.3.3 Quality Inspections

1.3.3.1 Government Inspections

Work performed under this contract will be subject to inspection by the Contracting Officer. Changes to the specifications or drawings will not be allowed without written authorization of the Contracting Officer.

When the Contracting Officer determines that inspected work needs to be corrected, the Contracting Officer will be allowed 24 hours to complete reinspection of the corrected work.

Contracting Officer shall also be notified in writing before backfilling or encasing any underground utility so that work may be inspected. Failure to notify the Contracting Officer before backfill or encasement occurs shall require the work be uncovered at no additional cost to the Government.

Contractor's program is subject to continuous evaluation, review, and verification by the Contracting Officer. Contractor will be notified in writing of any noncompliance and will be given 15 calendar days to correct identified deficiencies.

1.3.3.2 Contractor's Quality Inspections

Contractor shall implement an inspection system. Documentation shall indicate quality control through records of inspections, tests, and procedures.

Contractor's quality assurance system shall include the following:

- a. Single Contractor's representative responsible for on-site communication and operation of the inspection program.
- b. Purchasing control system documenting project procurement to drawings, specifications, and approved submittals.
- c. Receiving inspection system documenting inspections for each procurement.
- d. Documentation for handling and disposing of nonconforming components and materials.
- e. Inspection records for each specific section of the specification and drawings.
- f. Identification of test(s) to be performed, test procedures, records, and independent organizations used.
- g. Documenting and maintaining certification or re-certification of procedures.
- h. Management of government-furnished equipment, components, and materials.
- i. Calibration of gages, tools, measuring instruments, and independent laboratories used.

Contractor shall establish a system of scheduled or random audits to ensure task completion.

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1.3.4 Field Services

1.3.4.1 Responsibility for Inspection and Testing

Contractor shall be responsible for all inspections and tests, and the accompanying documentation for each inspection and test. Contractor may utilize independent inspection and testing laboratories or services as approved by the Contracting Officer.

Contractor shall also be responsible for tests of construction materials utilizing the services of an approved independent testing laboratory.

1.3.4.2 Inspection and Test Records

Contractor shall provide on-site records of each inspection and test performed throughout the life of the contract. Records shall include, but not be limited to, factual evidence that the required inspections or tests have been performed, including type and number of inspections or tests involved, identification of operators and inspectors, result of inspections or tests, nature of defects, causes for rejection, proposed remedial action, and corrective actions taken.

Inspection records, test procedures, test results, and associated forms be verified by and provided to the Contracting Officer. Final test data shall have a cover letter/sheet clearly marked with the system name, date, and the words "Final Test Data - Forward to the Systems Engineer/Condition Monitoring Office/Predictive Testing Group for inclusion in the Maintenance Database."

1.4 HANDLING AND STORAGE

Contractor shall provide controls, procedures and documentation with each shipment, that meet requirements of each section of the specifications.

The Contractor shall include documentation with each shipment. The data shall consist of documentation required by the contract along with specifications required to identify, store, preserve, operate, and maintain the items shipped.

1.5 SEQUENCING AND SCHEDULING

Contractor shall notify the Government at least 24 hours prior to scheduled inspections and tests.

Contractor shall provide 24 hour notice to the Government of the date when the contract work will begin at the site.

When Contractor suspends work for 7 calendar days or longer prior to completion, the Contracting Officer shall be notified. Work shall not resume without notification of the Contracting Officer.

Contracting Officer shall be notified at least 24 hours in advance of backfilling or encasing any underground utility.

PART 2 PRODUCTS

Not Used

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PART 3 EXECUTION

Not Used

-- End of Section --

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SECTION 01 50 00.98

TEMPORARY FACILITIES AND CONTROLS

04/06

PART 1 GENERAL

1.1 SUMMARY

Requirements of this Section apply to, and are a component of, each section of the specifications.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

U.S. FEDERAL AVIATION ADMINISTRATION (FAA)

FAA AC 70/7460-1

(Rev K) Obstruction Marking and Lighting

1.3 SUBMITTALS

Not Used

PART 2 PRODUCTS

2.1 CONSTRUCTION SIGN

Contractor shall provide a construction identification sign.

Sign shall comprise a face sheet of 4- by 8-foot exterior grade plywood, 1/2-inch thick, mounted on a substantial frame of treated lumber. Frame and sign shall be given one coat of lead-free alkyd primer paint and two coats of an exterior type white enamel.

2.2 CONSTRUCTION DETAILS

Lettering and further details of construction shall be in accordance with the drawings.

PART 3 EXECUTION

3.1 TEMPORARY UTILITIES

Contractor shall provide temporary utilities required for construction. Materials may be new or used, shall be adequate for the required usage, shall not create unsafe conditions, and shall not violate applicable codes and standards.

Contractor shall provide a minimum of 2 aviation red or high intensity white obstruction lights on temporary structures (including cranes) over 100 feet above ground level. Light construction and installation shall comply with FAA AC 70/7460-1. Lights shall be operational during periods of reduced visibility, darkness, and as directed by the Contracting Officer.

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3.1.1 Electricity

Contractor shall provide connections, sized to provide service required for power and lighting. Feeder and branch wiring with area distribution boxes shall be located so that power is available throughout the project site by use of power cords. 120/240 electrical volt feeder service is available. Lighting shall be provided by the Contractor. Electricity used will be furnished by the Government.

3.1.2 Water

Contractor shall make connections to existing facilities to provide water for construction purposes. Water used will be furnished by the Government. Hose connections shall be fitted with anti-siphon devices. Domestic water shall not be discharged to the storm sewer system without approval of the Contracting Officer.

3.1.3 Telephone Service

Contractor shall provide telephone service. Contractor shall pay costs of service.

3.1.4 Sanitary Facilities

Contractor shall provide temporary sanitary facilities and shall service, clean, and maintain these facilities and enclosures. Temporary facilities shall be removed from the site at the completion of the work.

3.1.5 Fire Protection

Contractor shall provide temporary fire protection equipment for the protection of personnel and property during construction. Debris and flammable materials shall be removed daily to minimize potential hazards.

3.2 SIGNS

3.2.1 Construction Sign

Within 30 days after notice to proceed, the Contractor shall install the construction identification sign at the location designated by the Contracting Officer.

3.2.2 Other Signs and Advertisements

Only signs necessary to expedite deliveries, maintain traffic flow, promote safety (e.g. caution, danger, blasting, hardhat area), and prevent interference with Government operations shall be erected.

3.3 TRAFFIC PROVISIONS

3.3.1 Maintenance of Traffic

Contractor shall conduct his operations in a manner that will not close any thoroughfare or interfere in any way with traffic on railways or highways except with written permission of the Contracting Officer. Contractor may move oversized and slow-moving vehicles to the worksite provided requirements of the highway authority have been met.

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Work shall be conducted so as to minimize obstruction of traffic, and traffic shall be maintained on at least half of the roadway width at all times. Approval shall be obtained from the Contracting Officer prior to starting any activity that will obstruct traffic.

Contractor shall provide, erect, and maintain, at his own expense, lights, barriers, signals, passageways, detours, etc., that may be required.

3.3.2 Rush Hour Restrictions

Contractor shall not interfere with the peak traffic flows preceding and during normal operations without notification to and approval by the Contracting Officer.

3.3.3 Dust Control

Contractor's dust control methods and procedures shall be approved by the Contracting Officer. Dust abatement on access roads shall be treated with applications of calcium chloride, water sprinklers, or similar methods or treatment.

3.4 WASTE MANAGEMENT

3.4.1 Refuse Bins

Refuse bins shall not be overloaded. Liquid materials shall not be placed in dumpsters or bins. Leaking dumpsters shall be replaced. Dumpsters and bins shall not be cleaned on-site. Dumpsters shall remain covered except when actively being loaded.

3.5 PROTECTION OF EXISTING SYSTEMS

3.5.1 Utility

Connection to existing utilities, identified on the drawings to the Contractor, shall be protected from damage during construction activity.

3.5.2 Safety

Contractor shall protect the integrity of any installed safety systems or personnel safety devices.

If entrance into systems serving safety devices is required, the Contractor shall obtain prior approval from the Contracting Officer. If it is temporarily necessary to remove or disable personnel safety devices in order to accomplish contract requirements, the Contractor shall provide alternative means of protection prior to removing or disabling any permanently installed safety devices or equipment and shall obtain prior approval from the Contracting Officer.

-- End of Section --

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SECTION 01 57 23.98

TEMPORARY STORM WATER POLLUTION CONTROL 04/06

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D 4439	(1997) Standard Terminology for Geosynthetics
ASTM D 4491	(1999a; R 2004e1) Water Permeability of Geotextiles by Permittivity
ASTM D 4533	(2004) Trapezoid Tearing Strength of Geotextiles
ASTM D 4632	(1991; R 2003) Grab Breaking Load and Elongation of Geotextiles
ASTM D 4751	(2004) Determining Apparent Opening Size of a Geotextile
ASTM D 4873	(2002) Identification, Storage, and Handling of Geosynthetic Rolls and Samples

1.2 GENERAL

The Contractor shall implement the storm water pollution prevention measures specified in this section.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-07 Certificates

Mill Certificate or Affidavit

Certificate attesting that the Contractor has met all specified requirements.

1.4 EROSION AND SEDIMENT CONTROLS

The controls and measures required by the Contractor are described below.

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1.4.1 Stabilization Practices

The stabilization practices to be implemented shall include temporary seeding, mulching, vegetative buffer strips, protection of trees, and preservation of mature vegetation. On his daily CQC Report, the Contractor shall record the dates when the major grading activities occur, (e.g., clearing and grubbing, excavation, and grading); when construction activities temporarily or permanently cease on a portion of the site; and when stabilization practices are initiated. Except as provided in paragraphs UNSUITABLE CONDITIONS and NO ACTIVITY FOR LESS THAN 21 DAYS, stabilization practices shall be initiated as soon as practicable, but no more than 14 days, in any portion of the site where construction activities have temporarily or permanently ceased.

1.4.1.1 Unsuitable Conditions

Where the initiation of stabilization measures by the fourteenth day after construction activity temporarily or permanently ceases is precluded by unsuitable conditions caused by the weather, stabilization practices shall be initiated as soon as practicable after conditions become suitable.

1.4.1.2 No Activity for Less Than 21 Days

Where construction activity will resume on a portion of the site within 21 days from when activities ceased (e.g., the total time period that construction activity is temporarily ceased is less than 21 days), then stabilization practices do not have to be initiated on that portion of the site by the fourteenth day after construction activity temporarily ceased.

1.4.2 Structural Practices

Structural practices shall be implemented to divert flows from exposed soils, temporarily store flows, or otherwise limit runoff and the discharge of pollutants from exposed areas of the site. Structural practices shall be implemented in a timely manner during the construction process to minimize erosion and sediment runoff. Structural practices shall include the following devices. Location and details of installation and construction are shown on the drawings.

1.4.2.1 Silt Fences

The Contractor shall provide silt fences as a temporary structural practice to minimize erosion and sediment runoff. Silt fences shall be properly installed to effectively retain sediment immediately after completing each phase of work where erosion would occur in the form of sheet and rill erosion (e.g. clearing and grubbing, excavation, embankment, and grading). Silt fences shall be installed in the locations indicated on the drawings. Final removal of silt fence barriers shall be upon approval by the Contracting Officer.

1.4.2.2 Straw Bales

The Contractor shall provide bales of straw as a temporary structural practice to minimize erosion and sediment runoff. Bales shall be properly placed to effectively retain sediment immediately after completing each phase of work (e.g., clearing and grubbing, excavation, embankment, and grading) in each independent runoff area (e.g., after clearing and grubbing in a area between a ridge and drain, bales shall be placed as work progresses, bales shall be removed/replaced/relocated as needed for work to

ATTACHMENT A

progress in the drainage area). Areas where straw bales are to be used are shown on the drawings. Final removal of straw bale barriers shall be upon approval by the Contracting Officer. Rows of bales of straw shall be provided as follows:

- a. Along the downhill perimeter edge of all areas disturbed.
- b. Along the top of the slope or top bank of drainage ditches, channels, swales, etc. that traverse disturbed areas.
- c. Along the toe of all cut slopes and fill slopes of the construction areas.
- d. Perpendicular to the flow in the bottom of existing drainage ditches, channels, swales, etc. that traverse disturbed areas or carry runoff from disturbed areas.
- e. Perpendicular to the flow in the bottom of new drainage ditches, channels, and swales.
- f. At the entrance to culverts that receive runoff from disturbed areas.

1.4.2.3 Diversion Dikes

Diversion dikes shall have a maximum channel slope of 2 percent and shall be adequately compacted to prevent failure. The minimum height measured from the top of the dike to the bottom of the channel shall be 18 inches. The minimum base width shall be 6 feet and the minimum top width shall be 2 feet. The Contractor shall ensure that the diversion dikes are not damaged by construction operations or traffic. Diversion dikes shall be located as shown on the drawings.

PART 2 PRODUCTS

2.1 COMPONENTS FOR SILT FENCES

2.1.1 Filter Fabric

The geotextile shall comply with the requirements of ASTM D 4439, and shall consist of polymeric filaments which are formed into a stable network such that filaments retain their relative positions. The filament shall consist of a long-chain synthetic polymer composed of at least 85 percent by weight of ester, propylene, or amide, and shall contain stabilizers and/or inhibitors added to the base plastic to make the filaments resistance to deterioration due to ultraviolet and heat exposure. Synthetic filter fabric shall contain ultraviolet ray inhibitors and stabilizers to provide a minimum of six months of expected usable construction life at a temperature range of 0 to 120 degrees F. The filter fabric shall meet the following requirements:

FILTER FABRIC FOR SILT SCREEN FENCE

PHYSICAL PROPERTY	TEST PROCEDURE	STRENGTH REQUIREMENT
Grab Tensile	ASTM D 4632	100 lbs. min.
Elongation (%)		30 % max.
Trapezoid Tear	ASTM D 4533	55 lbs. min.

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FILTER FABRIC FOR SILT SCREEN FENCE

PHYSICAL PROPERTY	TEST PROCEDURE	STRENGTH REQUIREMENT
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Permittivity	ASTM D 4491	0.2 sec-1
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AOS (U.S. Std Sieve)	ASTM D 4751	20-100
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2.1.2 Silt Fence Stakes and Posts

The Contractor may use either wooden stakes or steel posts for fence construction. Wooden stakes utilized for silt fence construction, shall have a minimum cross section of 2 inches by 2 inches when oak is used and 4 inches by 4 inches when pine is used, and shall have a minimum length of 5 feet. Steel posts (standard "U" or "T" section) utilized for silt fence construction, shall have a minimum weight of 1.33 pounds per linear foot and a minimum length of 5 feet.

2.1.3 Mill Certificate or Affidavit

A mill certificate or affidavit shall be provided attesting that the fabric and factory seams meet chemical, physical, and manufacturing requirements specified above. The mill certificate or affidavit shall specify the actual Minimum Average Roll Values and shall identify the fabric supplied by roll identification numbers. The Contractor shall submit a mill certificate or affidavit signed by a legally authorized official from the company manufacturing the filter fabric.

2.1.4 Identification Storage and Handling

Filter fabric shall be identified, stored and handled in accordance with ASTM D 4873.

2.2 COMPONENTS FOR STRAW BALES

The straw in the bales shall be stalks from oats, wheat, rye, barley, rice, or from grasses such as byhalia, bermuda, etc., furnished in air dry condition. The bales shall have a standard cross section of 14 inches by 18 inches. All bales shall be either wire-bound or string-tied. The Contractor may use either wooden stakes or steel posts to secure the straw bales to the ground. Wooden stakes utilized for this purpose, shall have a minimum dimensions of 2 inches x 2 inches in cross section and shall have a minimum length of 3 feet. Steel posts (standard "U" or "T" section) utilized for securing straw bales, shall have a minimum weight of 1.33 pounds per linear foot and a minimum length of 3 feet.

PART 3 EXECUTION

3.1 INSTALLATION OF SILT FENCES

Silt fences shall extend a minimum of 16 inches above the ground surface and shall not exceed 34 inches above the ground surface. Filter fabric shall be from a continuous roll cut to the length of the barrier to avoid the use of joints. When joints are unavoidable, filter fabric shall be spliced together at a support post, with a minimum 6 inch overlap, and securely sealed. A trench shall be excavated approximately 4 inches wide and 4 inches deep on the upslope side of the location of the silt fence. The 4-inch by 4-inch trench shall be backfilled and the soil compacted over

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the filter fabric. Silt fences shall be removed upon approval by the Contracting Officer.

3.2 INSTALLATION OF STRAW BALES

Straw bales shall be placed in a single row, lengthwise on the contour, with ends of adjacent bales tightly abutting one another. Straw bales shall be installed so that bindings are oriented around the sides rather than along the tops and bottoms of the bales in order to prevent deterioration of the bindings. The barrier shall be entrenched and backfilled. A trench shall be excavated the width of a bale and the length of the proposed barrier to a minimum depth of 4 inches. After the bales are staked and chinked (gaps filled by wedging with straw), the excavated soil shall be backfilled against the barrier. Backfill soil shall conform to the ground level on the downhill side and shall be built up to 4 inches against the uphill side of the barrier. Loose straw shall be scattered over the area immediately uphill from a straw bale barrier to increase barrier efficiency. Each bale shall be securely anchored by at least two stakes driven through the bale. The first stake or steel post in each bale shall be driven toward the previously laid bale to force the bales together. Stakes or steel pickets shall be driven a minimum 18 inches deep into the ground to securely anchor the bales.

3.3 MAINTENANCE

The Contractor shall maintain the temporary and permanent vegetation, erosion and sediment control measures, and other protective measures in good and effective operating condition by performing routine inspections to determine condition and effectiveness, by restoration of destroyed vegetative cover, and by repair of erosion and sediment control measures and other protective measures. The following procedures shall be followed to maintain the protective measures.

3.3.1 Silt Fence Maintenance

Silt fences shall be inspected in accordance with paragraph INSPECTIONS. Any required repairs shall be made promptly. Close attention shall be paid to the repair of damaged silt fence resulting from end runs and undercutting. Should the fabric on a silt fence decompose or become ineffective, and the barrier is still necessary, the fabric shall be replaced promptly. Sediment deposits shall be removed when deposits reach one-third of the height of the barrier. When a silt fence is no longer required, it shall be removed. The immediate area occupied by the fence and any sediment deposits shall be shaped to an acceptable grade. The areas disturbed by this shaping shall receive erosion control if required by Section TURF AND GRASSES.

3.3.2 Straw Bale Maintenance

Straw bale barriers shall be inspected in accordance with paragraph INSPECTIONS. Close attention shall be paid to the repair of damaged bales, end runs and undercutting beneath bales. Necessary repairs to barriers or replacement of bales shall be accomplished promptly. Sediment deposits shall be removed when deposits reach one-half of the height of the barrier. Bale rows used to retain sediment shall be turned uphill at each end of each row. When a straw bale barrier is no longer required, it shall be removed. The immediate area occupied by the bales and any sediment deposits shall be shaped to an acceptable grade. The areas disturbed by this shaping shall be seeded in accordance with Section 32 92 23 SODDING

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TURF.

3.3.3 Diversion Dike Maintenance

Diversion dikes shall be inspected in accordance with paragraph INSPECTIONS. Close attention shall be paid to the repair of damaged diversion dikes and necessary repairs shall be accomplished promptly. When diversion dikes are no longer required, they shall be shaped to an acceptable grade. The areas disturbed by this shaping shall be seeded in accordance with Section 32 92 23 SODDING.

3.4 INSPECTIONS

3.4.1 General

The Contractor shall inspect disturbed areas of the construction site, areas used for storage of materials that are exposed to precipitation that have not been finally stabilized, stabilization practices, structural practices, other controls, and area where vehicles exit the site at least once every seven (7) calendar days and within 24 hours of the end of any storm that produces 0.5 inches or more rainfall at the site. Where sites have been finally stabilized, such inspection shall be conducted at least once every month.

3.4.2 Inspections Details

Disturbed areas and areas used for material storage that are exposed to precipitation shall be inspected for evidence of, or the potential for, pollutants entering the drainage system. Erosion and sediment control measures identified in the Storm Water Pollution Prevention Plan shall be observed to ensure that they are operating correctly. Discharge locations or points shall be inspected to ascertain whether erosion control measures are effective in preventing significant impacts to receiving waters. Locations where vehicles exit the site shall be inspected for evidence of offsite sediment tracking.

3.4.3 Inspection Reports

For each inspection conducted, the Contractor shall prepare a report summarizing the scope of the inspection, name(s) and qualifications of personnel making the inspection, the date(s) of the inspection, major observations relating to the implementation of the Storm Water Pollution Prevention Plan, maintenance performed, and actions taken. The report shall be furnished to the Contracting Officer within 24 hours of the inspection as a part of the Contractor's daily CQC REPORT. A copy of the inspection report shall be maintained on the job site.

-- End of Section --

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PRODUCT REQUIREMENTS

04/06

PART 1 GENERAL

1.1 SUMMARY

Requirements of this Section apply to, and are a component part of, each section of the specifications.

1.2 SUBMITTALS

Not Used

1.3 SHIPMENT AND PROTECTION OF MATERIAL AND EQUIPMENT

Shipments shall be addressed to the Contractor who shall be responsible for their receipt, unloading, handling, and storage at the site. Government will not accept deliveries on behalf of the Contractor or his subcontractors or assume responsibility for security of materials, equipment, or supplies delivered to the site.

Contractor shall protect and preserve materials, supplies, and equipment of every description (including property which may be Government-furnished or -owned) and work performed.

1.4 STORAGE AND PROTECTION OF MATERIAL

1.4.1 Salvage Material

Material to be salvaged and reinstalled by the Contractor shall be protected during removal and stored to prevent damage.

1.4.2 New Material and Construction Equipment

Only material and construction equipment designated for performance of contract work may be stored at the construction site or located in Government-controlled warehouses or shop facilities.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

Materials and equipment to be provided under this contract shall be standard catalogue products of manufacturers regularly engaged in the manufacture of the products. All material "cut sheets" and factory acceptance test data shall be provided to the Contracting Officer. Information and data shall have a cover letter/sheet clearly marked with the system name, date, and the words "Final Test Data - Forward to the Systems Engineer/Condition Monitoring Office/Predictive Testing Group for inclusion in the Maintenance Database."

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Material and equipment shall be installed in accordance with the requirements of the contract drawings , contract specifications and referenced standards and specifications.

PART 3 EXECUTION

Not Used

-- End of Section --

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SECTION 01 74 19

CONSTRUCTION AND DEMOLITION WASTE MANAGEMENT 01/07

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM E 1609 (2001) Development and Implementation of a Pollution Prevention Program

U.S. GREEN BUILDING COUNCIL (USGBC)

LEED (2002; R 2005) Leadership in Energy and Environmental Design(tm) Green Building Rating System for New Construction (LEED-NC)

1.2 GOVERNMENT POLICY

Government policy is to apply sound environmental principles in the design, construction and use of facilities. As part of the implementation of that policy the Contractor shall: (1) practice efficient waste management when sizing, cutting, and installing products and materials and (2) use all reasonable means to divert construction and demolition waste from landfills and incinerators and to facilitate their recycling or reuse. A minimum of 50 percent by weight of total project solid waste shall be diverted from the landfill.

1.3 MANAGEMENT

Develop and implement a waste management program in accordance with **ASTM E 1609** and as specified. Take a pro-active, responsible role in the management of construction and demolition waste and require all subcontractors, vendors, and suppliers to participate in the effort. Construction and demolition waste includes products of demolition or removal, excess or unusable construction materials, packaging materials for construction products, and other materials generated during the construction process but not incorporated into the work. In the management of waste consideration shall be given to the availability of viable markets, the condition of the material, the ability to provide the material in suitable condition and in a quantity acceptable to available markets, and time constraints imposed by internal project completion mandates. The Contractor is responsible for implementation of any special programs involving rebates or similar incentives related to recycling of waste. Revenues or other savings obtained for salvage, or recycling accrue to the Contractor. Appropriately permit firms and facilities used for recycling, reuse, and disposal for the intended use to the extent required by federal, state, and local regulations. Also, provide on-site instruction of appropriate separation, handling, recycling, salvage, reuse, and return

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methods to be used by all parties at the appropriate stages of the project.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Waste Management Plan

SD-11 Closeout Submittals

Records

1.5 MEETINGS

Conduct Construction Waste Management meetings. After award of the Contract and prior to commencement of work, schedule and conduct a meeting with the Contracting Officer to discuss the proposed Waste Management Plan and to develop a mutual understanding relative to the details of waste management. At a minimum, environmental and waste management goals and issues shall be discussed at the following additional meetings:

- a. Pre-bid meeting.
- b. Pre-demolition meeting.
- c. Regular site meetings.
- d. Work safety meetings.

1.6 WASTE MANAGEMENT PLAN

A waste management plan shall be submitted within 15 days after notice to proceed and not less than 10 days before the pre-demolition meeting. The plan shall demonstrate how the project waste diversion goal shall be met and shall include the following:

- a. Name of individuals on the Contractor's staff responsible for waste prevention and management.
- b. Actions that will be taken to reduce solid waste generation, including coordination with subcontractors to ensure awareness and participation.
- c. Description of the regular meetings to be held to address waste management.
- d. Description of the specific approaches to be used in recycling/reuse of the various materials generated, including the areas on site and equipment to be used for processing, sorting, and temporary storage of wastes.
- e. Characterization, including estimated types and quantities, of the waste to be generated.

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- f. Name of landfill and/or incinerator to be used and the estimated costs for use, assuming that there would be no salvage or recycling on the project.
- g. Identification of local and regional reuse programs, including non-profit organizations such as schools, local housing agencies, and organizations that accept used materials such as materials exchange networks and Habitat for Humanity. Include the name, location, and phone number for each reuse facility to be used, and provide a copy of the permit or license for each facility.
- h. List of specific waste materials that will be salvaged for resale, salvaged and reused on the current project, salvaged and stored for reuse on a future project, or recycled. Recycling facilities that will be used shall be identified by name, location, and phone number, including a copy of the permit or license for each facility.
- i. Identification of materials that cannot be recycled/reused with an explanation or justification, to be approved by the Contracting Officer.
- j. Description of the means by which any waste materials identified in item (h) above will be protected from contamination.
- k. Description of the means of transportation of the recyclable materials (whether materials will be site-separated and self-hauled to designated centers, or whether mixed materials will be collected by a waste hauler and removed from the site).
- l. Anticipated net cost savings determined by subtracting Contractor program management costs and the cost of disposal from the revenue generated by sale of the materials and the incineration and/or landfill cost avoidance.

Revise and resubmit Plan as required by the Contracting Officer. Approval of Contractor's Plan will not relieve the Contractor of responsibility for compliance with applicable environmental regulations or meeting project cumulative waste diversion requirement. Distribute copies of the Waste Management Plan to each subcontractor, the Quality Control Manager, and the Contracting Officer.

1.7 RECORDS

Records shall be maintained to document the quantity of waste generated; the quantity of waste diverted through sale, reuse, or recycling; and the quantity of waste disposed by landfill or incineration. Records shall be kept in accordance with the LEED Reference Guide and using the LEED Letter Template. Quantities may be measured by weight or by volume, but must be consistent throughout. List each type of waste separately noting the disposal or diversion date. Identify the landfill, recycling center, waste processor, or other organization used to process or receive the solid waste. Provide explanations for any waste not recycled or reused. With each application for payment, submit updated documentation for solid waste disposal and diversion, and submit manifests, weight tickets, receipts, and invoices specifically identifying the project and waste material. The records shall be made available to the Contracting Officer during construction, and a copy of the records shall be included in the LEED Documentation Notebook.

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1.8 REPORTS

Quarterly and final reports shall include project name, information for waste generated this quarter, and cumulative totals for the project. Each report shall include supporting documentation to include manifests, weight tickets, receipts, and invoices specifically identifying the project and waste material. Include timber harvest and demolition information, if any.

1.9 COLLECTION

Separate, store, protect, and handle at the site identified recyclable and salvageable waste products in a manner that maximizes recyclability and salvagability of identified materials. Provide the necessary containers, bins and storage areas to facilitate effective waste management and clearly and appropriately identify them. Provide materials for barriers and enclosures around recyclable material storage areas which are nonhazardous and recyclable or reusable. Locate out of the way of construction traffic. Provide adequate space for pick-up and delivery and convenience to subcontractors. Recycling and waste bin areas are to be kept neat and clean, and recyclable materials shall be handled to prevent contamination of materials from incompatible products and materials. Clean contaminated materials prior to placing in collection containers. Use cleaning materials that are nonhazardous and biodegradable. Handle hazardous waste and hazardous materials in accordance with applicable regulations.

1.9.1 Source Separated Method.

Waste products and materials that are recyclable shall be separated from trash and sorted as described below into appropriately marked separate containers and then transported to the respective recycling facility for further processing. Deliver materials in accordance with recycling or reuse facility requirements (e.g., free of dirt, adhesives, solvents, petroleum contamination, and other substances deleterious to the recycling process). Separate materials into the following category types as appropriate to the project waste and to the available recycling and reuse programs in the project area:

- a. Land clearing debris.
- b. Asphalt.
- c. Concrete and masonry.
- d. Metal (e.g. banding, stud trim, ductwork, piping, rebar, roofing, other trim, steel, iron, galvanized, stainless steel, aluminum, copper, zinc, lead brass, bronze).
 - (1) Ferrous.
 - (2) Non-ferrous.
- e. Wood (nails and staples allowed).
- f. Debris.
- g. Glass (colored glass allowed).
- h. Paper.

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- (1) Bond.
- (2) Newsprint.
- (3) Cardboard and paper packaging materials.
- i. Plastic.
 - (1) Type 1: Polyethylene Terephthalate (PET, PETE).
 - (2) Type 2: High Density Polyethylene (HDPE).
 - (3) Type 3: Vinyl (Polyvinyl Chloride or PVC).
 - (4) Type 4: Low Density Polyethylene (LDPE).
 - (5) Type 5: Polypropylene (PP).
 - (6) Type 6: Polystyrene (PS).
 - (7) Type 7: Other. Use of this code indicates that the package in question is made with a resin other than the six listed above, or is made of more than one resin listed above, and used in a multi-layer combination.
- j. Gypsum.
- k. Non-hazardous paint and paint cans.
- l. Carpet.
- m. Ceiling tiles.
- n. Insulation.
- o. Beverage containers.

1.9.2 Co-Mingled Method.

Waste products and recyclable materials shall be placed into a single container and then transported to a recycling facility where the recyclable materials are sorted and processed.

1.9.3 Other Methods.

Other methods proposed by the Contractor may be used when approved by the Contracting Officer.

1.10 DISPOSAL

Control accumulation of waste materials and trash. Recycle or dispose of collected materials off-site at intervals approved by the Contracting Officer and in compliance with waste management procedures. Except as otherwise specified in other sections of the specifications, disposal shall be in accordance with the following:

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1.10.1 Reuse.

First consideration shall be given to salvage for reuse since little or no re-processing is necessary for this method, and less pollution is created when items are reused in their original form. Coordinate reuse with the Contracting Officer. Sale or donation of waste suitable for reuse shall be considered.

1.10.2 Recycle.

Waste materials not suitable for reuse, but having value as being recyclable, shall be made available for recycling. All fluorescent lamps, HID lamps, and mercury-containing thermostats removed from the site shall be recycled. Arrange for timely pickups from the site or deliveries to recycling facilities in order to prevent contamination of recyclable materials.

1.10.3 Waste.

Materials with no practical use or economic benefit shall be disposed at a landfill or incinerator.

1.10.4 Return

Set aside and protect misdelivered and substandard products and materials and return to supplier for credit.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

Not used. -- End of Section --

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SECTION 01 78 00.98

CLOSEOUT SUBMITTALS

04/06

PART 1 GENERAL

1.1 SUMMARY

The requirements of this Section apply to, and are a component part of, each section of the specifications.

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

The following shall be submitted in accordance with paragraph entitled, "General," of this section.

Reproducible Drawings
CAD System Drawings

SD-02 Shop Drawings

As-Built Drawings shall be submitted in accordance with paragraph entitled, "General," of this section.

SD-03 Product Data

Spare Parts Data shall indicate manufacturer's name, part number, nomenclature, and stock level recommended for maintenance and repair. List those items that may be standard to the normal maintenance of the system.

SD-07 Certificates

A Work Plan shall be submitted in accordance with paragraph entitled, "General," of this section.

SD-08 Manufacturer's Instructions

The following shall be submitted in accordance with paragraph entitled, "General," of this section.

Preventative Maintenance and Condition Monitoring (Predictive Testing) and Inspection schedules shall be submitted by the Contractor with instructions that state when systems should be retested.

Schedule shall define the anticipated length of each test, test apparatus, number of personnel identified by responsibility, and a testing validation procedure permitting the record operation capability requirements. Each test feature; e.g., gpm, rpm, psi, shall have a signoff blank for the Contractor and Contracting

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Officer. A remarks column of the testing validation procedure shall include references to operating limits of time, pressure, temperature, volume, voltage, current, acceleration, velocity, alignment, calibration, adjustments, cleaning, or special system notes. Procedures for preventative maintenance, condition monitoring (predictive testing) and inspection, adjustment, lubrication and cleaning necessary to prevent failure shall be delineated.

Posted Instructions

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals shall be submitted in accordance with paragraph entitled, "Operation and Maintenance," of this section. Equipment data sheets will be included for each piece of equipment purchased and/or installed, with specific model numbers and optional equipment or features listed. Equipment data shall be provided on NASA Form C-134: "CMMS Request for Modification" by the Contractor or their designated subcontractor.

All O&M data shall be submitted on CD in a Adobe Acrobat version 6.0 or greater, PDF Format. The COTR will provide the Contractor with a structured file format for the purposes of archiving PDF files on the CD.

1.3 GENERAL

Reproducible Drawings and CAD System Drawings shall be submitted as follows:

CD showing each drawing, product data record, or log shall be submitted for historical record.

Final drawings shall incorporate contract changes and plan deviations. Lines, letters, and details will be sharp, clear, and legible. Additions or corrections to the drawings will be drawn to the scale of the original drawing. One copy, marked with review notations by the Contracting Officer, will be returned to the Contractor. Drawings are to be resubmitted within 30 calendar days after the completion of the representative work effort.

Documents shall be current. Contractor shall not conceal record information until as-built drawings have been made. Record drawings shall be submitted with a transmittal letter containing date, project title, Contractor's name and address, document list, and Contractor's signature.

As-Built Drawings shall be submitted under the following criteria:

In order to minimize the time for final payment at the completion of the project, the Contractor shall update the as-built drawings every month with the Contracting Officer's authorized representative. This update will be a part of "the monthly request for payment meeting," and payment--or a portion of the payment, including final payment--may be withheld until the as-built drawings have been updated, and accepted by the Contracting Officer.

After completion of all construction and before final payment is made under this contract, the Contractor shall provide the Contracting

ATTACHMENT A

Officer with one complete set of full size blue line contract drawings with alterations shown in red pencil.

Preventative Maintenance and Condition Monitoring (Predictive Testing) and Inspection schedules shall be submitted by the Contractor with instructions that state when systems should be retested.

Schedule shall define the anticipated length of each test, test apparatus, number of personnel identified by responsibility, and a testing validation procedure permitting the record operation capability requirements. Each test feature; e.g., gpm, rpm, psi, shall have a signoff blank for the Contractor and Contracting Officer. A remarks column of the testing validation procedure shall include references to operating limits of time, pressure, temperature, volume, voltage, current, acceleration, velocity, alignment, calibration, adjustments, cleaning, or special system notes. Procedures for preventative maintenance, inspection, adjustment, lubrication and cleaning necessary to minimize corrective maintenance and repair shall be delineated.

Repair requirements shall inform operators how to check out, troubleshoot, repair, and replace components of the system. Instructions shall include electrical and mechanical schematics and diagrams and diagnostic techniques necessary to enable operation and troubleshooting of the system after acceptance.

A Work Plan shall be submitted to the Contracting Officer for project closeout. Plan shall include all scheduled inspections, instruction classes, items, closeout dates for all functions, and shall list the required Government and Contractor personnel that will be taking part in these functions.

Posted Instructions shall be submitted by the Contractor with labels, signs, and templates of operating instructions that are required to be mounted or installed on or near the product for normal, safe operation.

Contractor shall submit 6 copies of the project operation and maintenance manuals 30 days prior to testing the system involved. Data shall be updated and resubmitted for final approval no later than 30 days prior to contract completion.

Spare Parts Data shall indicate manufacturer's name, part number, nomenclature, and stock level required for maintenance and repair. List those items that may be standard to the normal maintenance of the system.

Contractor shall supply number of items of each part, as indicated by stock level required in Spare Parts Data, for spare parts inventory. Provision of spare parts does not relieve the Contractor of responsibilities listed under the contract guarantee provisions.

1.4 WARRANTY OF CONSTRUCTION

In accordance with FAR clause 52.246-12 the Contractor shall provide a 1-year warranty from "acceptance of the work". NASA Glenn Research Center interprets this as 1-year from the completion date. Subcontracts or Supply Purchase Orders shall include these provisions. The following clarifications are made to assure complete understanding of warranty provisions:

The prime Contractor shall operate and maintain all equipment and

ATTACHMENT A

systems installed until the contract completion date. This includes maintenance service inspections, filter replacements and other work as recommended by the manufacturer. Following completion, the Government will assume O&M responsibilities in accordance with the manufacturer's recommendations.

The prime Contractor shall provide a written 1 -year warranty from the contract completion date to the Government covering all materials, labor and workmanship. Warranty repairs may require the services of subcontractors or suppliers, but shall be managed and coordinated by the prime.

The prime Contractor shall provide a 1-year certificate of warranty from each supplier or provider for all purchased equipment or systems. Requests for warranty repairs shall be made directly to the manufacturer or supplier.

This provision is not affected by the Government's beneficial use or occupancy prior to the final completion. The warranty date may be adjusted throughout the course of his contract as required to include contract time extensions with an equitable adjustment to the contract. Should the contractor complete the work ahead of schedule, the warranty provisions will be revised to reflect the actual completion.

The warranty start date for this contract is calculated as the bid guarantee date plus the awarded period of performance.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 OPERATION AND MAINTENANCE

Operation and Maintenance Manuals shall be consistent with the manufacturer's standard brochures, schematics, printed instructions, general operating procedures, and safety precautions. Information shall be bound in manual format and grouped by technical sections. Test data shall be legible and of good quality. Light-sensitive reproduction techniques are acceptable provided finished pages are clear, legible, and not subject to fading. Pages for vendor data and manuals shall have 10 millimeter holes and be bound in 3-ring, loose-leaf binders. Data shall be organized by separate index and tabbed sheets, in a loose-leaf binder. Binder shall lie flat with printed sheets that are easy to read. Caution and warning indications shall be clearly labeled.

Contractor shall submit classroom and field instructions in the operation and maintenance of systems equipment where required by the technical provisions. These services shall be directed by the Contractor, using the manufacturer's factory-trained personnel or qualified representatives. Contracting Officer shall be given 7 days written notice of scheduled instructional services. Instructional materials belonging to the manufacturer or vendor, such as lists, static exhibits, and visual aids, shall be made available to the Contracting Officer.

-- End of Section --

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SECTION 03 11 14.00 10

FORMWORK FOR CONCRETE 04/06

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ACI INTERNATIONAL (ACI)

ACI 347 (2004) Guide to Formwork for Concrete

APA - THE ENGINEERED WOOD ASSOCIATION (APA)

APA PS 1 (1995) Voluntary Product Standard for Construction and Industrial Plywood

ASTM INTERNATIONAL (ASTM)

ASTM C 1077 (2007) Standard Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation

ASTM C 31/C 31M (2006) Standard Practice for Making and Curing Concrete Test Specimens in the Field

ASTM C 39/C 39M (2005e1) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens

1.2 DESIGN REQUIREMENTS

The design, engineering, and construction of the formwork shall be the responsibility of the Contractor. The formwork shall be designed for anticipated live and dead loads. However, for surfaces with an ACI Class A surface designation, the allowable deflection for facing material between studs, for studs between walers and walers between bracing shall be limited to 0.0025 times the span. The formwork shall be designed as a complete system with consideration given to the effects of cementitious materials and mixture additives such as fly ash, cement type, plasticizers, accelerators, retarders, air entrainment, and others. The adequacy of formwork design and construction shall be monitored prior to and during concrete placement as part of the Contractor's approved Quality Control Plan.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

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SD-02 Shop Drawings

Shop Drawings

Drawings and design computations for all formwork required shall be submitted at least 21days either before fabrication on site or before delivery of prefabricated forms. If reshoring is permitted, the method, including location, order, and time of erection and removal shall also be submitted for review.

SD-03 Product Data

Materials

Manufacturer's literature shall be submitted for plywood, concrete form hard board, form accessories, prefabricated forms, and form coating, and form-lining materials.

1.4 SHOP DRAWINGS

The shop drawings and data submitted shall include the type, size, quantity, and strength of all materials of which the forms are made, the plan for jointing of facing panels, details affecting the appearance, and the assumed design values and loading conditions.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Forms and Form Liners

Forms and form liners shall be fabricated with facing materials that will produce a finish meeting the specified irregularities in formed surface requirements as defined in [ACI 347](#). Forms and form liners shall be fabricated with facing materials as specified below.

2.1.1.1 Class "A" Finish

This class of finish shall apply to all new curbing and sidewalks. The form facing material shall be composed of new, well-matched tongue-and-groove lumber or new plywood panels conforming to [APA PS 1](#), Grade B-B concrete form, Class I.

2.1.1.2 Class "D" Finish

This class of finish shall apply to all new concrete pads. The form facing may be of wood or steel.

2.1.2 Form Coating

Form coating shall be commercial formulation that will not bond with, stain, cause deterioration, or any other damage to concrete surfaces. The coating shall not impair subsequent treatment of concrete surfaces depending upon bond or adhesion nor impede the wetting of surfaces to be cured with water or curing compounds. If special form liners are to be used, the Contractor shall follow the recommendation of the form coating manufacturer.

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2.2 ACCESSORIES

Ties and other similar form accessories to be partially or wholly embedded in the concrete shall be of a commercially manufactured type. After the ends or end fasteners have been removed, the embedded portion of metal ties shall terminate not less than 2 inches from any concrete surface either exposed to view or exposed to water. Removable tie rods shall not be allowed in any locations. Plastic snap ties may be used in locations where the surface will not be exposed to view. Form ties shall be constructed so that the ends or end fasteners can be removed without spalling the concrete.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Form Construction

Forms shall be constructed true to the structural design and required alignment. The form surface and joints shall be mortar tight and supported to achieve safe performance during construction, concrete placement, and form removal. The Contractor shall continuously monitor the alignment and stability of the forms during all phases to assure the finished product will meet the required surface class specified in paragraph FORMS AND FORM LINERS and tolerances specified in paragraph DESIGN REQUIREMENTS. Failure of any supporting surface either due to surface texture, deflection or form collapse shall be the responsibility of the Contractor as will the replacement or correction of unsatisfactory surfaces. When forms for continuous surfaces are placed in successive units, care shall be taken to fit the forms over the completed surface to obtain accurate alignment of the surface and to prevent leakage of mortar. Forms shall not be re-used if there is any evidence of defects which would impair the quality of the resulting concrete surface. All surfaces of used forms shall be cleaned of mortar and any other foreign material before reuse.

3.1.2 Chamfering

All exposed joints, edges and external corners shall be chamfered by molding placed in the forms unless the drawings specifically state that chamfering is to be omitted or as otherwise specified. Chamfered joints shall not be permitted where earth or rockfill is placed in contact with concrete surfaces. Chamfered joints shall be terminated twelve inches outside the limit of the earth or rockfill so that the end of the chamfers will be clearly visible.

3.1.3 Coating

Forms for exposed or painted surfaces shall be coated with form oil or a form-release agent before the form or reinforcement is placed in final position. The coating shall be used as recommended in the manufacturer's instructions. Forms for unexposed surfaces may be wet with water in lieu of coating immediately before placing concrete, except that, in cold weather when freezing temperatures are anticipated, coating shall be mandatory. Surplus coating on form surfaces and coating on reinforcing steel and construction joints shall be removed before placing concrete.

3.2 FORM REMOVAL

Forms shall not be removed without approval. The minimal time required for concrete to reach a strength adequate for removal of formwork without

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risking the safety of workers or the quality of the concrete depends on a number of factors including, but not limited to, ambient temperature, concrete lift heights, type and amount of concrete admixture, and type and amount of cementitious material in the concrete. It is the responsibility of the Contractor to consider all applicable factors and leave the forms in place until it is safe to remove them. In any case forms shall not be removed unless the minimum time requirements below are met, except as otherwise directed or specifically authorized. When conditions are such as to justify the requirement, forms will be required to remain in place for a longer period. All removal shall be accomplished in a manner which will prevent damage to the concrete and ensure the complete safety of the structure. Where forms support more than one element, the forms shall not be removed until the form removal criteria are met by all supported elements. Evidence that concrete has gained sufficient strength to permit removal of forms shall be determined by tests on control cylinders. All control cylinders shall be stored in the structure or as near the structure as possible so they receive the same curing conditions and protection methods as given those portions of the structure they represent. Control cylinders shall be removed from the molds at an age of no more than 24 hours. All control cylinders shall be prepared and tested in accordance with [ASTM C 31/C 31M](#) and [ASTM C 39/C 39M](#) at the expense of the Contractor by an independent laboratory that complies with [ASTM C 1077](#) and shall be tested within 4 hours after removal from the site.

-- End of Section --

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SECTION 03 15 13.00 10

EXPANSION JOINTS, CONTRACTION JOINTS, AND WATERSTOPS 04/06

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN HARDBOARD ASSOCIATION (AHA)

AHA A135.4 (2004) Basic Hardboard

ASTM INTERNATIONAL (ASTM)

ASTM C 919 (2002) Use of Sealants in Acoustical Applications

ASTM D 1751 (2004) Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)

ASTM D 1752 (2004a) Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion

ASTM D 2628 (1991; R 2005) Standard Specification for Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements

ASTM D 5249 (1995; R 2006) Backer Material for Use with Cold-and Hot-Applied Joint Sealants in Portland-Cement Concrete and Asphalt Joints

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Waterstops

Shop drawings and fabrication drawings provided by the manufacturer or prepared by the Contractor.

SD-03 Product Data

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Preformed Expansion Joint Filler Sealant

Manufacturer's literature, including safety data sheets, for preformed fillers and the lubricants used in their installation; field-molded sealants and primers (when required by sealant manufacturer); preformed compression seals; and waterstops. Manufacturer's recommended instructions for installing preformed fillers, field-molded sealants; preformed compression seals; and waterstops; and for splicing non-metallic waterstops.

SD-04 Samples

SD-07 Certificates

Preformed Expansion Joint Filler Sealant

Certificates of compliance stating that the joint filler and sealant materials and waterstops conform to the requirements specified.

1.3 DELIVERY AND STORAGE

Material delivered and placed in storage shall be stored off the ground and protected from moisture, dirt, and other contaminants. Sealants shall be delivered in the manufacturer's original unopened containers. Sealants whose shelf life has expired shall be removed from the site.

PART 2 PRODUCTS

2.1 CONTRACTION JOINT STRIPS

Contraction joint strips shall be 1/8 inch thick tempered hardboard conforming to AHA A135.4, Class 1. In lieu of hardboard strips, rigid polyvinylchloride (PVC) or high impact polystyrene (HIPS) insert strips specifically designed to induce controlled cracking in slabs on grade may be used. Such insert strips shall have removable top section.

2.2 PREFORMED EXPANSION JOINT FILLER

Expansion joint filler shall be preformed material conforming to ASTM D 1751 or ASTM D 1752. Unless otherwise indicated, filler material shall be 3/8 inch thick and of a width applicable for the joint formed. Backer material, when required, shall conform to ASTM D 5249.

2.3 SEALANT

Joint sealant shall conform to the following:

2.3.1 Preformed Polychloroprene Elastomeric Type

ASTM D 2628.

PART 3 EXECUTION

3.1 JOINTS

Joints shall be installed at locations indicated and as authorized.

ATTACHMENT A

3.1.1.1 Contraction Joints

Contraction joints may be constructed by inserting tempered hardboard strips or rigid PVC or HIPS insert strips into the plastic concrete using a steel parting bar, when necessary, or by cutting the concrete with a saw after concrete has set. Joints shall be approximately 1/8 inch wide and shall extend into the slab one-fourth the slab thickness, minimum, but not less than 1 inch.

3.1.1.1.1 Joint Strips

Strips shall be of the required dimensions and as long as practicable. After the first floating, the concrete shall be grooved with a tool at the joint locations. The strips shall be inserted in the groove and depressed until the top edge of the vertical surface is flush with the surface of the slab. The slab shall be floated and finished as specified. Working of the concrete adjacent to the joint shall be the minimum necessary to fill voids and consolidate the concrete. Where indicated, the top portion of the strip shall be sawed out after the curing period to form a recess for sealer. The removable section of PVC or HIPS strips shall be discarded and the insert left in place. True alignment of the strips shall be maintained during insertion.

3.1.1.2 Sawed Joints

Joint sawing shall be early enough to prevent uncontrolled cracking in the slab, but late enough that this can be accomplished without appreciable spalling. Concrete sawing machines shall be adequate in number and power, and with sufficient replacement blades to complete the sawing at the required rate. Joints shall be cut to true alignment and shall be cut in sequence of concrete placement. Sludge and cutting debris shall be removed.

3.1.2 Expansion Joints

Preformed expansion joint filler shall be used in expansion and isolation joints in slabs around columns and between slabs on grade and vertical surfaces where indicated. The filler shall extend the full slab depth, unless otherwise indicated. The edges of the joint shall be neatly finished with an edging tool of 1/8 inch radius, except where a resilient floor surface will be applied. Where the joint is to receive a sealant, the filler strips shall be installed at the proper level below the finished floor with a slightly tapered, dressed and oiled wood strip temporarily secured to the top to form a recess to the size shown on the drawings. The wood strip shall be removed after the concrete has set. Contractor may opt to use a removable expansion filler cap designed and fabricated for this purpose in lieu of the wood strip. The groove shall be thoroughly cleaned of laitance, curing compound, foreign materials, protrusions of hardened concrete, and any dust which shall be blown out of the groove with oil-free compressed air.

3.1.3 Joint Sealant

Sawed contraction joints and expansion joints in slabs shall be filled with joint sealant, unless otherwise shown. Joint surfaces shall be clean, dry, and free of oil or other foreign material which would adversely affect the bond between sealant and concrete. Joint sealant shall be applied as recommended by the manufacturer of the sealant.

ATTACHMENT A

3.1.3.1 Joints With Preformed Compression Seals

Compression seals shall be installed with equipment capable of installing joint seals to the prescribed depth without cutting, nicking, twisting, or otherwise distorting or damaging the seal or concrete and with no more than 5 percent stretching of the seal. The sides of the joint and, if necessary, the sides of the compression seal shall be covered with a coating of lubricant. Butt joints shall be coated with liberal applications of lubricant.

3.1.3.2 Joints With Field-Molded Sealant

Joints shall not be sealed when the sealant material, ambient air, or concrete temperature is less than 40 degrees F. When the sealants are meant to reduce the sound transmission characteristics of interior walls, ceilings, and floors the guidance provided in ASTM C 919 shall be followed. Joints requiring a bond breaker shall be coated with curing compound or with bituminous paint. Bond breaker and back-up material shall be installed where required. Joints shall be primed and filled flush with joint sealant in accordance with the manufacturer's recommendations.

-- End of Section --

ATTACHMENT A

SECTION 03 30 00

CAST-IN-PLACE CONCRETE

01/08

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ACI INTERNATIONAL (ACI)

ACI/MCP-1 (2007) Manual of Concrete Practice Part 1:
ACI 104-71R-97 to 223-98

ACI/MCP-2 (2007) Manual of Concrete Practice Part 2
- ACI 224R-01 to ACI 313R-97

ACI/MCP-3 (2007) Manual of Concrete Practice Part 3
- ACI 315-99 to ACI 343R-95

ACI/MCP-4 (2006) Manual of Concrete Practice Part 4
- ACI 345R-05 to 355.2R-04

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 182 (2005) Standard Specification for Burlap
Cloth Made from Jute or Kenaf and Cotton
Mats

AASHTO M 53 (1996) Standard Specification Axle-Steel
Deformed and Plain Bars for Concrete
Reinforcement

AMERICAN HARDBOARD ASSOCIATION (AHA)

AHA A135.4 (2004) Basic Hardboard

ASTM INTERNATIONAL (ASTM)

ASTM A 123/A 123M (2002) Standard Specification for Zinc
(Hot-Dip Galvanized) Coatings on Iron and
Steel Products

ASTM A 185/A 185M (2007) Standard Specification for Steel
Welded Wire Reinforcement, Plain, for
Concrete

ASTM A 496/A 496M (2007) Standard Specification for Steel
Wire, Deformed, for Concrete Reinforcement

ASTM A 497/A 497M (2007) Standard Specification for Steel
Welded Wire Reinforcement, Deformed, for
Concrete

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ASTM A 53/A 53M	(2007) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 615/A 615M	(2007) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A 767/A 767M	(2005) Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement
ASTM A 775/A 775M	(2007b) Standard Specification for Epoxy-Coated Steel Reinforcing Bars
ASTM A 780	(2001; R 2006) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A 82/A 82M	(2007) Standard Specification for Steel Wire, Plain, for Concrete Reinforcement
ASTM A 934/A 934M	(2007) Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars
ASTM A 996/A 996M	(2006a) Standard Specification for Rail-Steel and Axle-Steel Deformed Bars or Concrete Reinforcement
ASTM C 1107/C 1107M	(2007a) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM C 143/C 143M	(2005a) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C 150	(2007) Standard Specification for Portland Cement
ASTM C 156	(2005) Standard Test Method for Water Retention by Concrete Curing Materials
ASTM C 171	(2007) Standard Specification for Sheet Materials for Curing Concrete
ASTM C 172	(2007) Standard Practice for Sampling Freshly Mixed Concrete
ASTM C 173/C 173M	(2007) Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C 192/C 192M	(2007) Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
ASTM C 231	(2004) Standard Test Method for Air

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	Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 233	(2007) Standard Test Method for Air-Entraining Admixtures for Concrete
ASTM C 260	(2006) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C 309	(2007) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C 31/C 31M	(2006) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C 311	(2005) Sampling and Testing Fly Ash or Natural Pozzolans for Use as a Mineral Admixture in Portland-Cement Concrete
ASTM C 33	(2003) Standard Specification for Concrete Aggregates
ASTM C 39/C 39M	(2005e1) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C 42/C 42M	(2004) Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C 494/C 494M	(2005a) Standard Specification for Chemical Admixtures for Concrete
ASTM C 595	(2007) Standard Specification for Blended Hydraulic Cements
ASTM C 618	(2005) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C 881/C 881M	(2002) Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C 920	(2005) Standard Specification for Elastomeric Joint Sealants
ASTM C 932	(2006) Standard Specification for Surface-Applied Bonding Compounds for Exterior Plastering
ASTM C 94/C 94M	(2007) Standard Specification for Ready-Mixed Concrete
ASTM C 989	(2006) Standard Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars

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ASTM D 1190	(1997) Standard Specification for Concrete Joint Sealer, Hot-Applied Elastic Type
ASTM D 1557	(2002e1) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft ³) (2700 kN-m/m ³)
ASTM D 1751	(2004) Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D 1752	(2004a) Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion
ASTM D 4397	(2002) Standard Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications
ASTM D 5759	(1995; R 2005) Characterization of Coal Fly Ash and Clean Coal Combustion Fly Ash for Potential Uses
ASTM D 7116	(2005) Standard Specification for Joint Sealants, Hot Applied, Jet Fuel Resistant Types, for Portland Cement Concrete
ASTM E 329	(2007a) Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction
ASTM E 648	(2006a) Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source

CONCRETE REINFORCING STEEL INSTITUTE (CRSI)

CRSI 10MSP	(2001; 27Ed) Manual of Standard Practice
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FOREST STEWARDSHIP COUNCIL (FSC)

FSC STD 01 001	(2000) Principles and Criteria for Forest Stewardship
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NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST PS 1	(2007) Construction and Industrial Plywood
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U.S. DEPARTMENT OF COMMERCE (DOC)

PS1	(1995) Construction and Industrial Plywood (APA V995)
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U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS LLL-B-810	(Rev B) Building Board, (Hardboard) Hard Pressed, Vegetable Fiber
FS MMM-A-001993	(1978) Adhesive, Epoxy, Flexible, Filled (For Binding, Sealing, and Grouting)
FS SS-S-200	(Rev E; Am 2) Sealant, Joint, Two-Component, Jet-Blast-Resistant, Cold-Applied, for Portland Cement Concrete Pavement

1.2 DEFINITIONS

- a. "Cementitious material" as used herein must include all portland cement, pozzolan, fly ash, ground granulated blast-furnace slag, and silica fume.
- b. "Exposed to public view" means situated so that it can be seen from eye level from a public location after completion of the building. A public location is accessible to persons not responsible for operation or maintenance of the building.
- c. "Chemical admixtures" are materials in the form of powder or fluids that are added to the concrete to give it certain characteristics not obtainable with plain concrete mixes.
- d. "Workability (or consistence)" is the ability of a fresh (plastic) concrete mix to fill the form/mould properly with the desired work (vibration) and without reducing the concrete's quality. Workability depends on water content, chemical admixtures, aggregate (shape and size distribution), cementitious content and age (level of hydration).

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fabrication Drawings for concrete formwork must be submitted by the Contractor in accordance with paragraph entitled, "Shop Drawings," of this section, to include the following:

Reproductions of contract drawings are unacceptable.

Provide erection drawings for concrete **Formwork** that show placement of reinforcement and accessories, with reference to the contract drawings.

SD-03 Product Data

Materials for curing concrete
Joint sealants;

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Submit manufacturer's product data, indicating VOC content. Manufacturer's catalog data for the following items must include printed instructions for admixtures, bonding agents, epoxy-resin adhesive binders, waterstops, and liquid chemical floor hardeners.

Joint filler
Plastic Forms
Carton Forms
Recycled Aggregate Materials
Cement
Portland Cement
Ready-Mix Concrete
Water-Vapor Barrier Subgrade Cover
Bonding Materials

Concrete Curing Materials
Reinforcement
Reinforcement Materials

Submit documentation indicating percentage of post-industrial and post-consumer recycled content per unit of product. Indicate relative dollar value of recycled content products to total dollar value of products included in project.

Vapor retarder

SD-05 Design Data

Concrete mix design

Thirty days minimum prior to concrete placement, submit a mix design for each strength and type of concrete. Submit a complete list of materials including type; brand; source and amount of cement, fly ash, pozzolans, silica fume, ground slag, and admixtures; and applicable reference specifications. Provide mix proportion data using at least three different water-cement ratios for each type of mixture, which produce a range of strength encompassing those required for each class and type of concrete required. If source material changes, resubmit mix proportion data using revised source material. Provide only materials that have been proven by trial mix studies to meet the requirements of this specification, unless otherwise approved in writing by the Contracting Officer. Indicate clearly in the submittal where each mix design is used when more than one mix design is submitted. Submit additional data regarding concrete aggregates if the source of aggregate changes. Submit copies of the fly ash, silica fume and pozzolan test results, in addition. The approval of fly ash, silica fume, and pozzolan test results must be within 6 months of submittal date. Obtain acknowledgement of receipt prior to concrete placement.

Calculations

SD-06 Test Reports

Concrete mix design; G

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Fly ash

Pozzolan

Ground granulated blast-furnace slag

Compressive strength tests

Air Content

Slump

Air Entrainment

SD-07 Certificates

Curing concrete elements

SD-08 Manufacturer's Instructions

Fly ash

1.4 MODIFICATION OF REFERENCES

Accomplish work in accordance with ACI publications except as modified herein. Consider the advisory or recommended provisions to be mandatory. Interpret reference to the "Building Official," the "Structural Engineer," and the "Architect/Engineer" to mean the Contracting Officer.

1.5 DELIVERY, STORAGE, AND HANDLING

Do not deliver concrete until vapor barrier, forms, reinforcement, embedded items, and chamfer strips are in place and ready for concrete placement. [ACI/MCP-2](#) for job site storage of materials. Protect materials from contaminants such as grease, oil, and dirt. Ensure materials can be accurately identified after bundles are broken and tags removed. Do not store concrete curing compounds or sealers with materials that have a high capacity to adsorb volatile organic compound (VOC) emissions. Do not store concrete curing compounds or sealers in occupied spaces.

1.5.1 Reinforcement

Store reinforcement of different sizes and shapes in separate piles or racks raised above the ground to avoid excessive rusting. Protect from contaminants such as grease, oil, and dirt. Ensure bar sizes can be accurately identified after bundles are broken and tags removed.

1.6 QUALITY ASSURANCE

1.6.1 Design Data

1.6.2 Drawings

1.6.2.1 Shop Drawings

[Fabrication Drawings](#) for concrete formwork for [Reinforcement Materials](#),

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Column Forms, Wall Forms, Floor Forms, Ceiling Forms and for Special Construction must indicate concrete pressure calculations with both live and dead loads, along with material types. Provide all design calculations in accordance with ACI/MCP-2 and ACI/MCP-3.

1.6.2.2 Reinforcing Steel

ACI/MCP-4. Indicate bending diagrams, assembly diagrams, splicing and laps of bars, shapes, dimensions, and details of bar reinforcing, accessories, and concrete cover. Do not scale dimensions from structural drawings to determine lengths of reinforcing bars.

1.6.3 Control Submittals

1.6.3.1 Curing Concrete Elements

Submit proposed materials and methods for curing concrete elements.

1.6.3.2 Form Removal Schedule

Submit schedule for form removal indicating element and minimum length of time for form removal.

1.6.3.3 Material Safety Data Sheets

Submit Material Safety Data Sheets (MSDS) for all materials that are regulated for hazardous health effects. Prominently post the MSDS at the construction site.

1.6.4 Test Reports

1.6.4.1 Concrete Mix Design

Submit copies of laboratory test reports showing that the mix has been successfully tested to produce concrete with the properties specified and that mix must be suitable for the job conditions. Include mill test and all other test for cement, silica fume, aggregates, and admixtures in the laboratory test reports. Provide maximum nominal aggregate size, gradation analysis, percentage retained and passing sieve, and a graph of percentage retained verses sieve size. Submit test reports along with the concrete mix design. Obtain approval before concrete placement.

1.6.4.2 Fly Ash and Pozzolan

Submit test results in accordance with ASTM C 618 for fly ash and pozzolan. Submit test results performed within 6 months of submittal date. Submit manufacturer's policy statement on fly ash use in concrete.

1.6.4.3 Ground Granulated Blast-Furnace Slag

Submit test results in accordance with ASTM C 989 for ground granulated blast-furnace slag. Submit test results performed within 6 months of submittal date. Submit manufacturer's policy statement on slag use in concrete.

1.6.5 Special Finisher Qualifications

For 35 percent or more fly ash content as a percentage of cementitious materials, finisher must have a minimum of 3 years' experience finishing

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high-volume fly ash concrete.

1.7 SUSTAINABLE DESIGN REQUIREMENTS

1.7.1 Local/Regional Materials

Use materials or products extracted, harvested, or recovered, as well as manufactured, within a 500 mile radius from the project site, if available from a minimum of three sources.

1.7.2 Forest Stewardship Council (FSC) Certification

Use FSC-certified wood where specified. Provide letter of certification signed by lumber supplier. Indicate compliance with FSC STD 01 001 and identify certifying organization. Submit FSC certification numbers; identify each certified product on a line-item basis. Submit copies of invoices bearing the FSC certification numbers.

1.8 QUALIFICATIONS FOR CONCRETE TESTING SERVICE

Perform concrete testing by an approved laboratory and inspection service experienced in sampling and testing concrete. Testing agency must meet the requirements of ASTM E 329.

1.9 CONCRETE SAMPLING AND TESTING

Testing by the Contractor must include sampling and testing concrete materials proposed for use in the work and testing the design mix for each class of concrete. Perform quality control testing during construction.

Sample and test concrete aggregate materials proposed for use in the work in accordance with ASTM C 33.

Sample and test portland cement in accordance with ASTM C 150.

Sample and test air-entraining admixtures in accordance with ASTM C 233.

Testing must be performed by a Grade I Testing Technician.

PART 2 PRODUCTS

2.1 MATERIALS FOR FORMS

Provide wood, plywood, plastic, carton, or steel. Use plywood or steel forms where a smooth form finish is required.

2.1.1 Wood Forms

Provide lumber that is square edged or tongue-and-groove boards, free of raised grain, knotholes, or other surface defects. Provide plywood that complies with PS1, B-B concrete form panels or better or AHA A135.4, hardboard for smooth form lining. Virgin wood used must be FSC-certified.

2.1.1.1 Concrete Form Plywood (Standard Rough)

Provide plywood that conforms to NIST PS 1, B-B, concrete form, not less than 5/8-inch thick.

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2.1.1.2 Overlaid Concrete Form Plywood (Standard Smooth)

Provide plywood that conforms to **NIST PS 1**, B-B, high density form overlay, not less than **5/8-inch** thick.

2.1.2 Plastic Forms

Provide plastic forms that contain a minimum of 50 percent post-consumer recycled content, or a minimum of 50 percent post-industrial recycled content.

2.1.3 Steel Forms

Provide steel form surfaces that do not contain irregularities, dents, or sags.

2.2 FORM TIES AND ACCESSORIES

The use of wire alone is prohibited. Provide form ties and accessories that do not reduce the effective cover of the reinforcement.

2.2.1 Dovetail Anchor Slot

Preformed metal slot approximately **1 by 1 inch** of not less than 22 gage galvanized steel cast in concrete. Coordinate actual size and throat opening with dovetail anchors and provide with removable filler material.

2.3 CONCRETE

2.3.1 Contractor-Furnished **Mix Design**

ACI/MCP-1, **ACI/MCP-2**, and **ACI/MCP-3** except as otherwise specified. Indicate the compressive strength (f'c) of the concrete for each portion of the structure(s).

Maximum slump shown above may be increased **1 inch** for methods of consolidation other than vibration. Slump may be increased to **8 inches** when superplasticizers are used. Provide air entrainment using air-entraining admixture. Provide air entrainment within plus or minus 1.5 percent of the value specified.

2.3.1.1 Mix Proportions for Normal Weight Concrete

Trial design batches, mixture proportioning studies, and testing requirements for various classes and types of concrete specified are the responsibility of the Contractor. Base mixture proportions on compressive strength as determined by test specimens fabricated in accordance with **ASTM C 192/C 192M** and tested in accordance with **ASTM C 39/C 39M**. Samples of all materials used in mixture proportioning studies must be representative of those proposed for use in the project and must be accompanied by the manufacturer's or producer's test report indicating compliance with these specifications. Base trial mixtures having proportions, consistencies, and air content suitable for the work on methodology described in **ACI/MCP-1**. In the trial mixture, use at least three different water-cement ratios for each type of mixture, which must produce a range of strength encompassing those required for each class and type of concrete required on the project. The maximum water-cement ratio required must be based on equivalent water-cement ratio calculations as

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determined by the conversion from the weight ratio of water to cement plus pozzolan, silica fume, and ground granulated blast-furnace slag by weight equivalency method. Design laboratory trial mixture for maximum permitted slump and air content. Each combination of material proposed for use must have separate trial mixture, except for accelerator or retarder use can be provided without separate trial mixture. Report the temperature of concrete in each trial batch. For each water-cement ratio, at least three test cylinders for each test age must be made and cured in accordance with [ASTM C 192/C 192M](#) and tested in accordance with [ASTM C 39/C 39M](#) for 7 and 28 days. From these results, plot a curve showing the relationship between water-cement ratio and strength for each set of trial mix studies. In addition, plot a curve showing the relationship between 7 and 28 day strengths.

2.3.1.2 Required Average Strength of Mix Design

The selected mixture must produce an average compressive strength exceeding the specified strength by the amount indicated in [ACI/MCP-2](#). When a concrete production facility has a record of at least 15 consecutive tests, the standard deviation must be calculated and the required average compressive strength must be determined in accordance with [ACI/MCP-2](#). When a concrete production facility does not have a suitable record of tests to establish a standard deviation, the required average strength must follow [ACI/MCP-2](#) requirements.

2.3.2 Ready-Mix Concrete

Provide concrete that meets the requirements of [ASTM C 94/C 94M](#).

Ready-mixed concrete manufacturer must provide duplicate delivery tickets with each load of concrete delivered. Provide delivery tickets with the following information in addition to that required by [ASTM C 94/C 94M](#):

Type and brand cement

Cement content in [95-pound](#) bags per cubic [yard](#) of concrete

Maximum size of aggregate

Amount and brand name of admixtures

Total water content expressed by water/cement ratio

2.3.3 Concrete Curing Materials

2.3.3.1 Absorptive Cover

Provide burlap cloth cover for curing concrete made from jute or kenaf, weighing [10 ounces](#) plus or minus 5 percent per square [yard](#) when clean and dry, conforming to [ASTM C 171](#), Class 3; or cover may be cotton mats as approved.

2.3.3.2 Moisture-Retaining Cover

Provide waterproof paper cover for curing concrete conforming to [ASTM C 171](#), regular or white, or polyethylene sheeting conforming to [ASTM C 171](#), or polyethylene-coated burlap consisting of a laminate of burlap and a white opaque polyethylene film permanently bonded to the burlap; burlap must conform to [ASTM C 171](#), Class 3, and polyethylene film must conform to

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ASTM C 171. When tested for water retention in accordance with **ASTM C 156**, weight of water lost 72 hours after application of moisture retaining covering material must not exceed 0.039 gram per square centimeter of the mortar specimen surface.

2.3.3.3 Membrane-Forming Curing Compound

Provide liquid type compound conforming to **ASTM C 309**, Type 1, clear, Type 1D with fugitive dye for interior work and Type 2, white, pigmented for exterior work.

2.4 MATERIALS

2.4.1 Cement

ASTM C 150, Type I or II or **ASTM C 595**, Type IP(MH) or IS(MH) blended cement except as modified herein. Provide blended cement that consists of a mixture of **ASTM C 150**, Type II, cement and one of the following materials: **ASTM C 618** pozzolan or fly ash, **ASTM C 989** ground granulated blast-furnace slag. For portland cement manufactured in a kiln fueled by hazardous waste, maintain a record of source for each batch. Supplier must certify that no hazardous waste is used in the fuel mix or raw materials. For exposed concrete, use one manufacturer for each type of cement, ground slag, fly ash, and pozzolan.

2.4.1.1 Fly Ash and Pozzolan

ASTM C 618, Type N, F, or C, except that the maximum allowable loss on ignition must be 6 percent for Types N and F. Add with cement. Fly ash content must be a minimum of 15 percent by weight of cementitious material, provided the fly ash does not reduce the amount of cement in the concrete mix below the minimum requirements of local building codes. Where the use of fly ash cannot meet the minimum level, provide the maximum amount of fly ash permissible that meets the code requirements for cement content. Report the chemical analysis of the fly ash in accordance with **ASTM C 311**. Evaluate and classify fly ash in accordance with **ASTM D 5759**.

High contents of supplementary cementitious materials can have some detrimental effects on the concrete properties, such as slowing excessively the strength gain rate, and delaying and increasing the difficulty of finishing. The recommended maximum content (by weight of the total cementitious material) for these materials are:

1. For GGBF slag: 50 percent
2. For fly ash or natural pozzolan: 40 percent (25 percent in cold climates)
3. For silica fume: 10 percent

2.4.1.2 Ground Granulated Blast-Furnace Slag

ASTM C 989, Grade 100. Slag content must be a minimum of 25 percent by weight of cementitious material.

2.4.1.3 Portland Cement

Provide cement that conforms to **ASTM C 150**, Type I, IA, II, or IIA. Use one brand and type of cement for formed concrete having exposed-to-view

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finished surfaces.

2.4.2 Water

Minimize the amount of water in the mix. The amount of water must not exceed 45 percent by weight of cementitious materials (cement + pozzolans), and in general, improve workability by adjusting the grading rather than by adding water. Water must be fresh, clean, and potable; free from injurious amounts of oils, acids, alkalis, salts, organic materials, or other substances deleterious to concrete.

2.4.3 Aggregates

ASTM C 33, except as modified herein. Furnish aggregates for exposed concrete surfaces from one source. Provide aggregates that do not contain any substance which may be deleteriously reactive with the alkalis in the cement.

2.4.3.1 Recycled Aggregate Materials

Use a minimum of 50 percent recycled aggregate, depending on local availability and conforming to requirements of the mix design. Recycled aggregate to include: recovered glass, recovered concrete, recovered porcelain, AND recovered stone that meets the aggregate requirements specified. Submit recycled material request with the aggregate certification submittals and do not use until approved by the Contracting Officer.

2.4.4 Nonshrink Grout

ASTM C 1107/C 1107M.

2.4.5 Admixtures

ASTM C 494/C 494M: Type A, water reducing; Type B, retarding; Type C, accelerating; Type D, water-reducing and retarding; and Type E, water-reducing and accelerating admixture. Do not use calcium chloride admixtures.

2.4.5.1 Air-Entraining

ASTM C 260.

2.4.5.2 Pozzolan

Provide fly ash or other pozzolans used as admixtures that conform to ASTM C 618.

2.4.6 Vapor Retarder

ASTM D 4397 polyethylene sheeting, minimum 6 mil thickness.

Consider plastic vapor retarders and adhesives with a high recycled content, low toxicity low VOC (Volatile Organic Compounds) levels.

2.4.7 Materials for Curing Concrete

Use water-based curing compounds, sealers, and coatings with low (maximum

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160 grams/liter, less water and less exempt compounds) zero VOC content.

Consider the use of water based or vegetable or soy based curing agents in lieu of petroleum based products. Consider agents that are not toxic and emit low or no Volatile Organic Compounds (VOC). Consider the use of admixtures that offer high performance to increase durability of the finish product but also have low toxicity and are made from bio-based materials such as soy, and emit low levels of Volatile Organic Compounds (VOC).

2.4.7.1 Impervious Sheeting

ASTM C 171; waterproof paper, clear or white polyethylene sheeting, or polyethylene-coated burlap.

2.4.7.2 Pervious Sheeting

AASHTO M 182.

2.4.7.3 Liquid Membrane-Forming Compound

ASTM C 309, white-pigmented, Type 2, Class B.

2.4.8 Expansion/Contraction Joint Filler

ASTM D 1751, ASTM D 1752, cork or 100% post-consumer paper meeting ASTM D 1752 (subparagraphs 5.1 to 5.4). Material must be 1/2 inch thick.

2.4.9 Joint Sealants

Use concrete penetrating sealers with a low (maximum 100 grams/liter, less water and less exempt compounds) VOC content.

2.4.9.1 Horizontal Surfaces, 3 Percent Slope, Maximum

ASTM D 1190 or ASTM C 920, Type M, Class 25, Use T. ASTM D 7116 for surfaces subjected to jet fuel.

2.4.9.2 Joint Sealant Compound

Provide hot-poured, elastic type compound conforming to ASTM D 1190.

Provide cold-applied, two-component, elastomeric polymer type compound conforming to FS SS-S-200.

2.4.10 Epoxy Bonding Compound

ASTM C 881/C 881M. Provide Type I for bonding hardened concrete to hardened concrete; Type II for bonding freshly mixed concrete to hardened concrete; and Type III as a binder in epoxy mortar or concrete, or for use in bonding skid-resistant materials to hardened concrete. Provide Grade 1 or 2 for horizontal surfaces and Grade 3 for vertical surfaces. Provide Class A if placement temperature is below 40 degrees F; Class B if placement temperature is between 40 and 60 degrees F; or Class C if placement temperature is above 60 degrees F.

2.5 REINFORCEMENT

Galvanize bars, fabrics, connectors, and chairs.

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2.5.1 Reinforcing Bars

ACI/MCP-2 unless otherwise specified. Use deformed steel. ASTM A 615/A 615M and AASHTO M 53 with the bars marked A, S, W, Grade 60; or ASTM A 996/A 996M with the bars marked R, Grade 60, or marked A, Grade 60. Galvanized, ASTM A 123/A 123M. Zinc-coated (galvanized) bars, ASTM A 767/A 767M and ASTM A 780.

2.5.1.1 Galvanized Reinforcing Bars

Provide galvanized reinforcing bars that conform to ASTM A 767/A 767M, Class II with galvanizing before fabrication.

2.5.1.2 Epoxy-Coated Reinforcing Bars

Provide epoxy-coated reinforcing bars that conform to ASTM A 775/A 775M, Grade 40 or Grade 60.

2.5.2 Mechanical Reinforcing Bar Connectors

ACI/MCP-2. Provide 125 percent minimum yield strength of the reinforcement bar.

2.5.3 Wire

ASTM A 82/A 82M or ASTM A 496/A 496M.

2.5.3.1 Welded Wire Fabric

ASTM A 185/A 185M or ASTM A 497/A 497M. Provide flat sheets of welded wire fabric for slabs and toppings.

2.5.3.2 Steel Wire

Wire must conform to ASTM A 82/A 82M.

2.5.4 Reinforcing Bar Supports

Provide bar ties and supports of coated or non corrodible material.

2.5.5 Chairs and Bolsters: Steel

Minimum 5 percent post-consumer recycled content, or minimum 20 percent post-industrial recycled content.

2.5.6 Dowels for Load Transfer in Floors

Provide dowels for load transfer in floors of the type, design, weight, and dimensions indicated. Provide dowel bars that are plain-billet steel conforming to ASTM A 615/A 615M, Grade 40. Provide dowel pipe that is steel conforming to ASTM A 53/A 53M.

2.5.7 Supports for Reinforcement

Supports include bolsters, chairs, spacers, and other devices necessary for proper spacing, supporting, and fastening reinforcing bars and wire fabric in place.

Provide wire bar type supports conforming to ACI/MCP-3 and CRSI 10MSP.

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Legs of supports in contact with formwork must be hot-dip galvanized, or plastic coated after fabrication, or stainless-steel bar supports.

2.6 BONDING MATERIALS

2.6.1 Concrete Bonding Agent

Provide aqueous-phase, film-forming, nonoxidizing, freeze and thaw-resistant compound agent suitable for brush or spray application conforming to ASTM C 932.

2.6.2 Epoxy-Resin Adhesive Binder

Provide two-component, epoxy-polysulfide polymer type binder with an amine-type curing-agent conforming to FS MMM-A-001993, Type I or ASTM C 881/C 881M.

2.7 CLASSIFICATION AND QUALITY OF CONCRETE

2.7.1 Concrete Classes and Usage

Provide concrete classes, compressive strength, requirements for air entrainment, and usage as follows:

<u>CONCRETE CLASS</u>	<u>MIN. 28-DAY COMPRESSIVE STRENGTH POUNDS PER SQ. IN.</u>	<u>REQUIREMENT FOR AIR ENTRAINMENT</u>	<u>USAGE</u>
3A	3,000	Air-entrained	For foundation concrete work exposed to freezing and thawing or subjected to hydraulic pressure, such as foundation walls, grade beams, pits, tunnels. For exterior concrete slabs, such as steps, platforms, walks

2.7.2 Limits for Concrete Proportions

Provide limits for maximum water/cement ratio and minimum cement content for each concrete class as follows:

<u>CONCRETE CLASS</u>	<u>MAX. WATER/CEMENT RATIO BY WEIGHT</u>	<u>MIN. CEMENT FOR 3- TO 4-INCH SLUMP, (NO. OF 94- POUND SACKS) PER CU. YD.</u>
3A	0.50	5.25

* Weight of water to weight of cement in pounds in one cubic yard of concrete

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2.7.3 Maximum Size of Aggregate

Size of aggregate, designated by the sieve size on which maximum amount of retained coarse aggregate is 5 to 10 percent by weight, must be as follows:

<u>MAXIMUM SIZE OF AGGREGATE</u>	<u>ASTM C 33 SIZE NUMBER</u>	<u>TYPE OF CONSTRUCTION</u>
2 inches	357	Nonreinforced footings and other flat work having a depth of not less than 6 inches, and nonreinforced walls and other formed sections having a dimension between forms of not less than 10 inches
1-1/2 inches	467	Monolithic slabs on ground, concrete fill, and other flatwork having a depth of not less than 5 inches and a clear distance between reinforcing bars of not less than 2 inches
3/4 inch	67	Reinforced walls, columns, girders, beams, and other formed sections having a dimension between forms of not less than 6 inches and clear distance between reinforcing bars or reinforcing bar and face of form of not less than 1 inch
3/4 inch	67	Monolithic concrete slabs and other flatwork having a depth of not less than 2-1/2 inches and a clear distance between reinforcing bars of not less than 1 inch
1/2 inch	7	Concrete joist construction, beams, reinforced walls, and other formed work having a clear distance between reinforcing bars and face of form of less than 1 inch
3/8 inch	8	Nonreinforced slabs and other flatwork having a depth of less than 2-1/2 inches

Maximum size of aggregate may be that required for most critical type of construction using that concrete class.

Specify gradation of aggregates for separate floor topping.

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2.7.4 Slump

Provide slump for concrete at time and in location of placement as follows:

<u>TYPE OF CONSTRUCTION</u>	<u>SLUMP</u>
Footings, unreinforced walls	Not less than 1 inch nor more than 3 inches
Ramps and other sloping surfaces	0 nor more than 3 inches

2.7.5 Total Air Content

Air content of exposed concrete and interior concrete must be in accordance with **ASTM C 260** and/or as follows:

<u>LIMITS</u>	<u>REQUIREMENT</u>	<u>MAXIMUM SIZE</u>	<u>TOTAL AIR CONTENT</u>
<u>CONCRETE</u>	<u>FOR AIR</u>	<u>OF AGGREGATE</u>	<u>BY VOLUME</u>
<u>EXPOSURE</u>	<u>ENTRAINMENT</u>		
Exposed to	Air-	1-1/2 or	4 to 6 percent
freezing	entrained	2 inches	
and thawing		3/4 inch	5 to 7 percent
or subjected			
to hydraulic		1/2 or	6 to 8.5 percent
pressure		3/8 inch	

Provide concrete exposed to freezing and thawing or subjected to hydraulic pressure that is air-entrained by addition of approved air-entraining admixture to concrete mix.

PART 3 EXECUTION

3.1 EXAMINATION

Do not begin installation until substrates have been properly constructed; verify that substrates are plumb and true.

If substrate preparation is the responsibility of another installer, notify Architect/Engineer of unsatisfactory preparation before processing.

Check field dimensions before beginning installation. If dimensions vary too much from design dimensions for proper installation, notify Architect/Engineer and wait for instructions before beginning installation.

3.2 PREPARATION

Determine quantity of concrete needed and minimize the production of excess concrete. Designate locations or uses for potential excess concrete before the concrete is poured.

3.2.1 General

Surfaces against which concrete is to be placed must be free of debris, loose material, standing water, snow, ice, and other deleterious substances before start of concrete placing.

Remove standing water without washing over freshly deposited concrete.

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Divert flow of water through side drains provided for such purpose.

3.2.2 Subgrade Under Foundations and Footings

When subgrade material is semiporous and dry, sprinkle subgrade surface with water as required to eliminate suction at the time concrete is deposited. When subgrade material is porous, seal subgrade surface by covering surface with specified water barrier subgrade cover; this may also be used over semiporous, dry subgrade material instead of water sprinkling.

3.2.3 Subgrade Under Slabs on Ground

Before construction of slabs on ground, have underground work on pipes and conduits completed and approved.

Previously constructed subgrade or fill must be cleaned of foreign materials and inspected by the Contractor for adequate compaction and surface tolerances as specified.

Actual density of top 12 inches of subgrade soil material-in-place must not be less than the following percentages of maximum density of same soil material compacted at optimum moisture content in accordance with ASTM D 1557.

<u>SOIL MATERIAL</u>	<u>PERCENT MAXIMUM DENSITY</u>
Drainage fill	100
Cohesionless soil material	100
Cohesive soil material	95

Finish surface of drainage fill under interior slabs on ground must not show deviation in excess of 1/4 inch when tested with a 10-foot straightedge parallel with and at right angles to building lines.

Finished surface of subgrade or fill under exterior slabs on ground must not be more than 0.02-foot above or 0.10-foot below elevation indicated.

Cover drainage fill surface under interior slabs on ground with specified water-vapor barrier subgrade cover immediately prior to placing reinforcement. Install subgrade cover to avoid puncture or tear. Patch punctures or tears over 12 inches with separate sheets lapped not less than 6 inches. Seal all punctures or tears less than 12 inches with pressure-sensitive vapor barrier tape not less than 2-inches wide. Seal lapped joints with vapor barrier adhesive or pressure-sensitive vapor barrier tape not less than 2-inches wide. Lay subgrade cover sheets with not less than a 6-inch lap at edges and ends and in direction in which concrete is to be placed.

Prepare subgrade or fill surface under exterior slabs on ground as specified for subgrade under foundations and footings.

3.2.4 Formwork

Complete and approve formwork. Remove debris and foreign material from interior of forms before start of concrete placing.

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3.2.5 Edge Forms and Screed Strips for Slabs

Set edge forms or bulkheads and intermediate screed strips for slabs to obtain indicated elevations and contours in finished slab surface and must be strong enough to support vibrating bridge screeds or roller pipe screeds if nature of specified slab finish requires use of such equipment. Align concrete surface to elevation of screed strips by use of strike-off templates or approved compacting-type screeds.

3.2.6 Reinforcement and Other Embedded Items

Secure reinforcement, joint materials, and other embedded materials in position, inspected, and approved before start of concrete placing.

3.3 FORMS

ACI/MCP-2. Provide forms, shoring, and scaffolding for concrete placement. Set forms mortar-tight and true to line and grade. Chamfer above grade exposed joints, edges, and external corners of concrete **0.75 inch** unless otherwise indicated. Provide formwork with clean-out openings to permit inspection and removal of debris. Forms submerged in water must be watertight.

3.3.1 General

Construct forms to conform, within the tolerances specified, to shapes dimensions, lines, elevations, and positions of cast-in-place concrete members as indicated. Forms must be supported, braced, and maintained sufficiently rigid to prevent deformation under load.

3.3.2 Design and Construction of Formwork

Provide formwork design and construction that conforms to and **ACI/MCP-2**, Chapter 4.

Provide forms that are tight to prevent leakage of cement paste during concrete placing.

Support form facing materials by structural members spaced close to prevent deflection of form facing material. Fit forms placed in successive units for continuous surfaces to accurate alignment to ensure a smooth completed surface within the tolerances specified. Where necessary to maintain the tolerances specified, such as long spans where immediate supports are not possible, camber formwork for anticipated deflections in formwork due to weight and pressure of fresh concrete and to construction loads.

Chamfer exposed joints, edges, and external corners a minimum of **3/4 inch** by moldings placed in corners of column, beam, and wall forms.

Provide shores and struts with a positive means of adjustment capable of taking up formwork settlement during concrete placing operations. Obtain adjustment with wedges or jacks or a combination thereof. When adequate foundations for shores and struts cannot be secured, provide trussed supports.

Provide temporary openings in wall forms, column forms, and at other points where necessary to permit inspection and to facilitate cleaning.

Provide forms that are readily removable without impact, shock, or damage

to concrete.

3.3.3 Coating

Before concrete placement, coat the contact surfaces of forms with a nonstaining mineral oil, nonstaining form coating compound, or two coats of nitrocellulose lacquer. Do not use mineral oil on forms for surfaces to which adhesive, paint, or other finish material is to be applied.

3.3.4 Reshoring

Reshore concrete elements where forms are removed prior to the specified time period. Do not permit elements to deflect or accept loads during form stripping or reshoring. Forms on columns, walls, or other load-bearing members may be stripped after 2 days if loads are not applied to the members. After forms are removed, reshore slabs and beams over 10 feet in span and cantilevers over 4 feet for the remainder of the specified time period in accordance with paragraph entitled "Removal of Forms." Perform reshoring operations to prevent subjecting concrete members to overloads, eccentric loading, or reverse bending. Provide reshoring elements with the same load-carrying capabilities as original shoring and spaced similar to original shoring. Firmly secure and brace reshoring elements to provide solid bearing and support.

3.3.5 Reuse

Reuse forms providing the structural integrity of concrete and the aesthetics of exposed concrete are not compromised.

3.3.6 Forms for Standard Rough Form Finish

Give rough form finish concrete formed surfaces that are to be concealed by other construction, unless otherwise specified.

Form facing material for standard rough form finish must be the specified concrete form plywood or other approved form facing material that produces concrete surfaces equivalent in smoothness and appearance to that produced by new concrete form plywood panels.

For concrete surfaces exposed only to the ground, undressed, square-edge, 1-inch nominal thickness lumber may be used. Provide horizontal joints that are level and vertical joints that are plumb.

3.3.7 Forms for Standard Smooth Form Finish

Give smooth form finish concrete formed surfaces that are to be exposed to view or that are to be covered with coating material applied directly to concrete or with covering material bonded to concrete, such as waterproofing, dampproofing, painting, or other similar coating system.

Form facing material for standard smooth finish must be the specified overlaid concrete form plywood or other approved form facing material that is nonreactive with concrete and that produce concrete surfaces equivalent in smoothness and appearance to that produced by new overlaid concrete form plywood panels.

Maximum deflection of form facing material between supports and maximum deflection of form supports such as studs and wales must not exceed 0.0025 times the span.

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Provide arrangement of form facing sheets that are orderly and symmetrical, and sheets that are in sizes as large as practical.

Arrange panels to make a symmetrical pattern of joints. Horizontal and vertical joints must be solidly backed and butted tight to prevent leakage and fins.

3.3.8 Form Ties

Provide ties that are factory fabricated metal, adjustable in length, removable or snap-off type that do allow form deflection or do not spall concrete upon removal. Portion of form ties remaining within concrete after removal of exterior parts must be at least 1-1/2 inches back from concrete surface. Provide form ties that are free of devices that leave a hole larger than 7/8 inch or less than 1/2 inch in diameter in concrete surface. Form ties fabricated at the project site or wire ties of any type are not acceptable.

3.3.9 Forms for Concrete Pan Joist Construction

Provide forms that are well-fitting, undamaged, factory-fabricated pan form units for concrete joist construction as indicated.

Form units complete with covers and end closures as required for the installation must be one of the following materials:

Steel, 16-gage, free from irregularities, dents, sag, and rust

Hardboard conforming to FS LLL-B-810, 1/4-inch thick, coated with waterproof plastic

Glass-fiber-reinforced plastic, molded under pressure, with matched dies, 0.11-inch maximum wall thickness

Asphalt-impregnated, corrugated material treated for moisture resistance with factory-applied polyethylene coating, with top and side cover joints taped where concrete is exposed.

Provide tight forms for concrete pan joist construction to prevent cement paste loss during concrete placing and to form a true, clean, smooth surface, free of honeycomb and rough exposed-aggregate areas. Take precautions, including blocking of adjoining pan units, to avoid lateral deflection of formwork during compaction of concrete.

3.3.10 Tolerances for Form Construction

Construct formwork to ensure that after removal of forms and prior to patching and finishing of formed surfaces, provide concrete surfaces in accordance with tolerances specified in ACI/MCP-1 and ACI/MCP-2.

3.3.11 Removal of Forms and Supports

After placing concrete, forms must remain in place for the time periods specified in ACI/MCP-4. Do not remove forms and shores (except those used for slabs on grade and slip forms) until the client determines that the concrete has gained sufficient strength to support its weight and superimposed loads. Base such determination on compliance with one of the following:

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- a. The plans and specifications stipulate conditions for removal of forms and shores, and such conditions have been followed, or
- b. The concrete has been properly tested with an appropriate ASTM standard test method designed to indicate the concrete compressive strength, and the test results indicate that the concrete has gained sufficient strength to support its weight and superimposed loads.

Prevent concrete damage during form removal. Clean all forms immediately after removal.

3.3.11.1 Special Requirements for Reduced Time Period

Forms may be removed earlier than specified if **ASTM C 39/C 39M** test results of field-cured samples from a representative portion of the structure indicate that the concrete has reached a minimum of 85 percent of the design strength.

3.4 FORMED SURFACES

3.4.1 Preparation of Form Surfaces

Coat contact surfaces of forms with form-coating compound before reinforcement is placed. Provide a commercial formulation form-coating compound that does not bond with, stain, nor adversely affect concrete surfaces and impair subsequent treatment of concrete surfaces that entails bonding or adhesion nor impede wetting of surfaces to be cured with water or curing compounds. Do not allow excess form-coating compound to stand in puddles in the forms nor to come in contact with concrete against which fresh concrete is placed. Make thinning of form-coating compound with thinning agent of the type, in the amount, and under the conditions recommended by form-coating compound manufacturer's printed or written directions.

3.4.2 Tolerances

ACI/MCP-4 and as indicated.

3.4.3 As-Cast Form

Provide form facing material producing a smooth, hard, uniform texture on the concrete. Arrange facing material in an orderly and symmetrical manner and keep seams to a practical minimum. Support forms as necessary to meet required tolerances. Do not use material with raised grain, torn surfaces, worn edges, patches, dents, or other defects which can impair the texture of the concrete surface.

3.5 PLACING REINFORCEMENT AND MISCELLANEOUS MATERIALS

ACI/MCP-2. Provide bars, wire fabric, wire ties, supports, and other devices necessary to install and secure reinforcement. Reinforcement must not have rust, scale, oil, grease, clay, or foreign substances that would reduce the bond. Rusting of reinforcement is a basis of rejection if the effective cross-sectional area or the nominal weight per unit length has been reduced. Remove loose rust prior to placing steel. Tack welding is prohibited.

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3.5.1 General

Provide details of reinforcement that are in accordance with, and [ACI/MCP-4](#) and as specified.

3.5.2 Reinforcement Supports

Place reinforcement and secure with galvanized or non corrodible chairs, spacers, or metal hangers. For supporting reinforcement on the ground, use concrete or other non corrodible material, having a compressive strength equal to or greater than the concrete being placed.

[ASTM A 934/A 934M](#). Rest epoxy-coated reinforcing bars supported from formwork on coated wire bar supports, or on bar supports made of dielectric material or other acceptable material. Coat wire bar supports with dielectric material, compatible with concrete, for a minimum distance of [2 inches](#) from the point of contact with the epoxy-coated reinforcing bars. Reinforcing bars used as support bars must be epoxy coated. Spreader bars, where used, must be epoxy coated. Make proprietary combination bar clips and spreaders used in construction with epoxy-coated reinforcing bars corrosion resistant or coated with dielectric material. Tie epoxy-coated bars with plastic-coated tie wire

3.5.3 Splicing

As indicated. For splices not indicated [ACI/MCP-2](#). Do not splice at points of maximum stress. Overlap welded wire fabric the spacing of the cross wires, plus [2 inches](#).

3.5.4 Future Bonding

Plug exposed, threaded, mechanical reinforcement bar connectors with a greased bolt. Provide bolt threads that match the connector. Countersink the connector in the concrete. Calk the depression after the bolt is installed.

3.5.5 Cover

[ACI/MCP-2](#) for minimum coverage, unless otherwise indicated.

3.5.6 Setting Miscellaneous Material

Place and secure anchors and bolts, pipe sleeves, conduits, and other such items in position before concrete placement. Plumb anchor bolts and check location and elevation. Temporarily fill voids in sleeves with readily removable material to prevent the entry of concrete.

3.5.7 Construction Joints

Locate joints to least impair strength. Continue reinforcement across joints unless otherwise indicated.

3.5.8 Expansion Joints and Contraction Joints

Provide expansion joint at edges of interior floor slabs on grade abutting vertical surfaces, and as indicated. Make expansion joints [1/2 inch](#) wide unless indicated otherwise. Fill expansion joints not exposed to weather with preformed joint filler material. Completely fill joints exposed to weather with joint filler material and joint sealant. Do not extend

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reinforcement or other embedded metal items bonded to the concrete through any expansion joint unless an expansion sleeve is used. Provide contraction joints, either formed or saw cut or cut with a jointing tool, to the indicated depth after the surface has been finished. Complete saw joints within 4 to 12 hours after concrete placement. Protect joints from intrusion of foreign matter.

3.5.9 Fabrication

Shop fabricate reinforcing bars to conform to shapes and dimensions indicated for reinforcement, and as follows:

Provide fabrication tolerances that are in accordance with [ACI/MCP-1](#), [ACI/MCP-2](#) and [ACI/MCP-3](#).

Provide hooks and bends that are in accordance with and [ACI/MCP-3](#).

Reinforcement must be bent cold to shapes as indicated. Bending must be done in the shop. Rebending of a reinforcing bar that has been bent incorrectly is not be permitted. Bending must be in accordance with standard approved practice and by approved machine methods.

Tolerance on nominally square-cut, reinforcing bar ends must be in accordance with [ACI/MCP-3](#).

Deliver reinforcing bars bundled, tagged, and marked. Tags must be metal with bar size, length, mark, and other information pressed in by machine. Marks must correspond with those used on the placing drawings.

Do not use reinforcement that has any of the following defects:

- a. Bar lengths, depths, and bends beyond specified fabrication tolerances
- b. Bends or kinks not indicated on drawings or approved shop drawings
- c. Bars with reduced cross-section due to rusting or other cause

Replace defective reinforcement with new reinforcement having required shape, form, and cross-section area.

3.5.10 Placing Reinforcement

Place reinforcement in accordance with [ACI/MCP-4](#).

For slabs on grade (over earth or over capillary water barrier) and for footing reinforcement, support bars or welded wire fabric on precast concrete blocks, spaced at intervals required by size of reinforcement, to keep reinforcement the minimum height specified above the underside of slab or footing.

For slabs other than on grade, supports for which any portion is less than [1 inch](#) from concrete surfaces that are exposed to view or to be painted must be of precast concrete units, plastic-coated steel, or stainless steel protected bar supports. Precast concrete units must be wedge shaped, not larger than [3-1/2 by 3-1/2 inches](#), and of thickness equal to that indicated for concrete protection of reinforcement. Provide precast units that have cast-in galvanized tie wire hooked for anchorage and blend with concrete surfaces after finishing is completed.

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Contractor must cooperate with other trades in setting of anchor bolts, inserts, and other embedded items. Where conflicts occur between locating reinforcing and embedded items, the Contractor must notify the Contracting Officer so that conflicts may be reconciled before placing concrete. Anchors and embedded items must be positioned and supported with appropriate accessories.

Handle epoxy-coated reinforcing bars carefully to prevent damage to the coating. Use plastic-coated tie wire and supports of a type to prevent damage to the reinforcing bars.

Provide reinforcement that is supported and secured together to prevent displacement by construction loads or by placing of wet concrete, and as follows:

Provide supports for reinforcing bars that are sufficient in number and sufficiently heavy to carry the reinforcement they support, and in accordance with [ACI/MCP-4](#) and [CRSI 10MSP](#). Do not use supports to support runways for concrete conveying equipment and similar construction loads.

Equip supports on ground and similar surfaces with sand-plates.

Support welded wire fabric as required for reinforcing bars.

Secure reinforcements to supports by means of tie wire. Wire must be black, soft iron wire, not less than [16 gage](#).

With the exception of temperature reinforcement, tied to main steel approximately [24 inches](#) on center, reinforcement must be accurately placed, securely tied at intersections with [18-gage](#) annealed wire, and held in position during placing of concrete by spacers, chairs, or other approved supports. Point wire-tie ends away from the form. Unless otherwise indicated, numbers, type, and spacing of supports must conform to [ACI/MCP-3](#).

Bending of reinforcing bars partially embedded in concrete is permitted only as specified in [ACI/MCP-4](#).

3.5.11 Spacing of Reinforcing Bars

Spacing must be as indicated. If not indicated, spacing must be in accordance with the [ACI/MCP-3](#).

Reinforcing bars may be relocated to avoid interference with other reinforcement, or with conduit, pipe, or other embedded items. If any reinforcing bar is moved a distance exceeding one bar diameter or specified placing tolerance, resulting rearrangement of reinforcement is subject to approval.

3.5.12 Concrete Protection for Reinforcement

Concrete protection must be in accordance with the [ACI/MCP-4](#), [ASTM E 648](#), and [ACI/MCP-3](#).

3.6 BATCHING, MEASURING, MIXING, AND TRANSPORTING CONCRETE

[ASTM C 94/C 94M](#), and [ACI/MCP-2](#), except as modified herein. Batching

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equipment must be such that the concrete ingredients are consistently measured within the following tolerances: 1 percent for cement and water, 2 percent for aggregate, and 3 percent for admixtures. Furnish mandatory batch ticket information for each load of ready mix concrete.

3.6.1 Measuring

Make measurements at intervals as specified in paragraphs entitled "Sampling" and "Testing."

3.6.2 Mixing

ASTM C 94/C 94M and ACI/MCP-2. Machine mix concrete. Begin mixing within 30 minutes after the cement has been added to the aggregates. Place concrete within 90 minutes of either addition of mixing water to cement and aggregates or addition of cement to aggregates if the air temperature is less than 84 degrees F. Reduce mixing time and place concrete within 60 minutes if the air temperature is greater than 84 degrees F except as follows: if set retarding admixture is used and slump requirements can be met, limit for placing concrete may remain at 90 minutes. Additional water may be added, provided that both the specified maximum slump and water-cement ratio are not exceeded. When additional water is added, an additional 30 revolutions of the mixer at mixing speed is required. If the entrained air content falls below the specified limit, add a sufficient quantity of admixture to bring the entrained air content within the specified limits. Dissolve admixtures in the mixing water and mix in the drum to uniformly distribute the admixture throughout the batch.

3.6.3 Transporting

Transport concrete from the mixer to the forms as rapidly as practicable. Prevent segregation or loss of ingredients. Clean transporting equipment thoroughly before each batch. Do not use aluminum pipe or chutes. Remove concrete which has segregated in transporting and dispose of as directed.

3.7 PLACING CONCRETE

Place concrete as soon as practicable after the forms and the reinforcement have been inspected and approved. Do not place concrete when weather conditions prevent proper placement and consolidation; in uncovered areas during periods of precipitation; or in standing water. Prior to placing concrete, remove dirt, construction debris, water, snow, and ice from within the forms. Deposit concrete as close as practicable to the final position in the forms. Do not exceed a free vertical drop of 3 feet from the point of discharge. Place concrete in one continuous operation from one end of the structure towards the other. Position grade stakes on 10 foot centers maximum in each direction when pouring interior slabs and on 20 foot centers maximum for exterior slabs.

3.7.1 General Placing Requirements

Deposit concrete continuously or in layers of such thickness that no concrete is placed on concrete which has hardened sufficiently to cause formation of seams or planes of weakness within the section. If a section cannot be placed continuously, provide construction joints as specified. Perform concrete placing at such a rate that concrete which is being integrated with fresh concrete is still plastic. Deposit concrete as nearly as practical in its final position to avoid segregation due to rehandling or flowing. Do not subject concrete to procedures which cause

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segregation.

Concrete to receive other construction must be screeded to proper level to avoid excessive skimming or grouting.

Do not use concrete which becomes nonplastic and unworkable or does not meet quality control limits as specified or has been contaminated by foreign materials. Use of retempered concrete is permitted. Remove rejected concrete from the site.

3.7.2 Vibration

ASTM A 775/A 775M. Furnish a spare, working, vibrator on the job site whenever concrete is placed. Consolidate concrete slabs greater than 4 inches in depth with high frequency mechanical vibrating equipment supplemented by hand spading and tamping. Consolidate concrete slabs 4 inches or less in depth by wood tampers, spading, and settling with a heavy leveling straightedge. Operate internal vibrators with vibratory element submerged in the concrete, with a minimum frequency of not less than 6000 impulses per minute when submerged. Do not use vibrators to transport the concrete in the forms. Insert and withdraw vibrators approximately 20 inches apart. Penetrate the previously placed lift with the vibrator when more than one lift is required. Place concrete in 20 inch maximum vertical lifts. Use external vibrators on the exterior surface of the forms when internal vibrators do not provide adequate consolidation of the concrete.

3.7.3 Application of Epoxy Bonding Compound

Apply a thin coat of compound to dry, clean surfaces. Scrub compound into the surface with a stiff-bristle brush. Place concrete while compound is stringy. Do not permit compound to harden prior to concrete placement. Follow manufacturer's instructions regarding safety and health precautions when working with epoxy resins.

3.7.4 Hot Weather

Maintain required concrete temperature using Figure 2.1.5 in **ACI/MCP-2** to prevent the evaporation rate from exceeding 0.2 pound of water per square foot of exposed concrete per hour. Cool ingredients before mixing or use other suitable means to control concrete temperature and prevent rapid drying of newly placed concrete. Shade the fresh concrete as soon as possible after placing. Start curing when the surface of the fresh concrete is sufficiently hard to permit curing without damage. Provide water hoses, pipes, spraying equipment, and water hauling equipment, where job site is remote to water source, to maintain a moist concrete surface throughout the curing period. Provide burlap cover or other suitable, permeable material with fog spray or continuous wetting of the concrete when weather conditions prevent the use of either liquid membrane curing compound or impervious sheets. For vertical surfaces, protect forms from direct sunlight and add water to top of structure once concrete is set.

3.7.5 Follow-up

Check concrete within 24 hours of placement for flatness, levelness, and other specified tolerances. Adjust formwork and placement techniques on subsequent pours to achieve specified tolerances.

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3.7.6 Placing Concrete in Forms

Deposit concrete placed in forms in horizontal layers not exceeding 24 inches.

Remove temporary spreaders in forms when concrete placing has reached elevation of spreaders.

Consolidate concrete placed in forms by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping. Design vibrators to operate with vibratory element submerged in concrete and maintain a speed of not less than 9,000 impulses per minute when submerged in concrete. Provide vibrating equipment adequate in number of units and power of each unit to properly consolidate concrete. Vibration of forms and reinforcement is not be permitted. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced points not farther apart than visible effectiveness of machine. Do not insert vibrator into lower courses of concrete that have begun to set. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing segregation of concrete mix.

Do not start placing of concrete in supporting elements until concrete previously placed in columns and walls is no longer plastic and has been in place a minimum of 2 hours.

3.7.7 Placing Concrete Slabs

Place and consolidate concrete for slabs in a continuous operation, within the limits of approved construction joints until placing of panel or section is completed.

During concrete placing operations, consolidate concrete by mechanical vibrating equipment so that concrete is worked around reinforcement and other embedded items and into corners. Consolidate concrete placed in beams and girders of supported slabs and against bulkheads of slabs on ground by mechanical vibrators as specified. Consolidate concrete in remainder of slabs by vibrating bridge screeds, roller pipe screeds, or other approved method. Limit consolidation operations to time necessary to obtain consolidation of concrete without bringing an excess of fine aggregate to the surface. Concrete to be consolidated must be as dry as practical and surfaces thereof must not be manipulated prior to finishing operations. Bring concrete correct level with a straightedge and struck-off. Use bull floats or darbies to smooth surface, leaving it free of humps or hollows. Sprinkling of water on plastic surface is not permitted.

Provide finish of slabs as specified.

3.7.8 Bonding

Surfaces of set concrete at joints, except where bonding is obtained by use of concrete bonding agent, must be roughened and cleaned of laitance, coatings, loose particles, and foreign matter. Roughen surfaces in a manner that exposes the aggregate uniformly and does not leave laitance, loosened particles of aggregate, nor damaged concrete at the surface.

Obtain bonding of fresh concrete that has set as follows:

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At joints between footings and walls or columns, between walls or columns and the beams or slabs they support, and elsewhere unless otherwise specified; roughened and cleaned surface of set concrete must be dampened, but not saturated, immediately prior to placing of fresh concrete.

At joints in exposed-to-view work; at vertical joints in walls; at joints near midpoint of span in girders, beams, supported slabs, other structural members; in work designed to contain liquids; the roughened and cleaned surface of set concrete must be dampened but not saturated and covered with a cement grout coating.

Provide cement grout that consists of equal parts of portland cement and fine aggregate by weight with not more than 6 gallons of water per sack of cement. Apply cement grout with a stiff broom or brush to a minimum thickness of 1/16 inch. Deposit fresh concrete before cement grout has attained its initial set.

Bonding of fresh concrete to concrete that has set may be obtained by use of a concrete bonding agent. Apply such bonding material to cleaned concrete surface in accordance with approved printed instructions of bonding material manufacturer.

3.8 SURFACE FINISHES EXCEPT FLOOR, SLAB, AND PAVEMENT FINISHES

3.8.1 Defects

Repair formed surfaces by removing minor honeycombs, pits greater than 1 square inch surface area or 0.25 inch maximum depth, or otherwise defective areas. Provide edges perpendicular to the surface and patch with nonshrink grout. Patch tie holes and defects when the forms are removed. Concrete with extensive honeycomb including exposed steel reinforcement, cold joints, entrapped debris, separated aggregate, or other defects which affect the serviceability or structural strength will be rejected, unless correction of defects is approved. Obtain approval of corrective action prior to repair. The surface of the concrete must not vary more than the allowable tolerances of ACI/MCP-4. Exposed surfaces must be uniform in appearance and finished to a smooth form finish unless otherwise specified.

3.8.2 Not Against Forms (Top of Walls)

Surfaces not otherwise specified must be finished with wood floats to even surfaces. Finish must match adjacent finishes.

3.8.3 Formed Surfaces

3.8.3.1 Tolerances

ACI/MCP-1 and as indicated.

3.8.3.2 As-Cast Rough Form

Provide for surfaces not exposed to public view. Patch these holes and defects and level abrupt irregularities. Remove or rub off fins and other projections exceeding 0.25 inch in height.

3.8.3.3 Standard Smooth Finish

Finish must be as-cast concrete surface as obtained with form facing

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material for standard smooth finish. Repair and patch defective areas as specified; and all fins and remove other projections on surface.

3.9 FLOOR, SLAB, AND PAVEMENT FINISHES AND MISCELLANEOUS CONSTRUCTION

3.9.1 Finish

Place, consolidate, and immediately strike off concrete to obtain proper contour, grade, and elevation before bleedwater appears. Permit concrete to attain a set sufficient for floating and supporting the weight of the finisher and equipment. If bleedwater is present prior to floating the surface, drag the excess water off or remove by absorption with porous materials. Do not use dry cement to absorb bleedwater.

3.9.1.1 Broomed

Use on surfaces of exterior walks, platforms, patios, and ramps, unless otherwise indicated. Perform a floated finish, then draw a broom or burlap belt across the surface to produce a coarse scored texture. Permit surface to harden sufficiently to retain the scoring or ridges. Broom transverse to traffic or at right angles to the slope of the slab.

3.9.1.2 Pavement

Screed the concrete with a template advanced with a combined longitudinal and crosswise motion. Maintain a slight surplus of concrete ahead of the template. After screeding, float the concrete longitudinally. Use a straightedge to check slope and flatness; correct and refloat as necessary. Obtain final finish by a burlap drag. Drag a strip of clean, wet burlap from 3 to 10 feet wide and 2 feet longer than the pavement width across the slab. Produce a fine, granular, sandy textured surface without disfiguring marks. Round edges and joints with an edger having a radius of 1/8 inch.

3.9.1.3 Concrete Toppings Placement

The following requirements apply to the placement of toppings of concrete on base slabs that are either freshly placed and still plastic, or on hardened base slabs.

- a. Placing on a Fresh Base: Screed and bull float the base slab. As soon as the water sheen has disappeared, lightly rake the surface of the base slab with a stiff bristle broom to produce a bonding surface for the topping. Immediately spread the topping mixture evenly over the roughened base before final set takes place. Give the topping the finish specified herein.
- b. Bonding to a Hardened Base: When the topping is to be bonded to a floated or troweled hardened base, roughen the base by scarifying, grit-blasting, scabbling, planing, flame cleaning, or acid-etching to lightly expose aggregate and provide a bonding surface. Remove dirt, laitance, and loose aggregate by means of a stiff wire broom. Keep the clean base wet for a period of 12 hours preceding the application of the topping. Remove excess water and apply a 1:1:1/2 cement-sand-water grout, and brush into the surface of the base slab. Do not allow the cement grout to dry, and spread it only short distances ahead of the topping placement. Do not allow the temperature differential between the completed base and the

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topping mixture to exceed 41 degrees F at the time of placing.
Place the topping and finish as specified herein.

3.9.2 Concrete Walks

Provide 4 inches thick minimum. Provide contraction joints spaced every 5 linear feet unless otherwise indicated. Cut contraction joints one inch deep with a jointing tool after the surface has been finished. Provide 0.5 inch thick transverse expansion joints at changes in direction where sidewalk abuts curb, steps, rigid pavement, or other similar structures; space expansion joints every 50 feet maximum. Give walks a broomed finish. Unless indicated otherwise, provide a transverse slope of 1/48. Limit variation in cross section to 1/4 inch in 5 feet.

3.9.3 Pits and Trenches

Place bottoms and walls monolithically or provide waterstops and keys.

3.9.4 Curbs and Gutters

Provide contraction joints spaced every 10 feet maximum unless otherwise indicated. Cut contraction joints 3/4 inch deep with a jointing tool after the surface has been finished. Provide expansion joints 1/2 inch thick and spaced every 100 feet maximum unless otherwise indicated. Perform pavement finish.

3.9.5 Splash Blocks

Provide at outlets of downspouts emptying at grade. Splash blocks may be precast concrete, and must be 24 inches long, 12 inches wide, and 4 inches thick, unless otherwise indicated, with smooth-finished countersunk dishes sloped to drain away from the building.

3.10 CURING AND PROTECTION

ACI/MCP-2 unless otherwise specified. Begin curing immediately following form removal. Avoid damage to concrete from vibration created by blasting, pile driving, movement of equipment in the vicinity, disturbance of formwork or protruding reinforcement, and any other activity resulting in ground vibrations. Protect concrete from injurious action by sun, rain, flowing water, frost, mechanical injury, tire marks, and oil stains. Do not allow concrete to dry out from time of placement until the expiration of the specified curing period. Do not use membrane-forming compound on surfaces where appearance would be objectionable, on any surface to be painted, where coverings are to be bonded to the concrete, or on concrete to which other concrete is to be bonded. If forms are removed prior to the expiration of the curing period, provide another curing procedure specified herein for the remaining portion of the curing period. Provide moist curing for those areas receiving liquid chemical sealer-hardener or epoxy coating. Allow curing compound/sealer installations to cure prior to the installation of materials that adsorb VOCs.

3.10.1 General

Protect freshly placed concrete from premature drying and cold or hot temperature and maintain without drying at a relatively constant temperature for the period of time necessary for hydration of cement and proper hardening of concrete.

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Start initial curing as soon as free water has disappeared from surface of concrete after placing and finishing. Keep concrete moist for minimum 72 hours.

Final curing must immediately follow initial curing and before concrete has dried. Continue final curing until cumulative number of hours or fraction thereof (not necessarily consecutive) during which temperature of air in contact with the concrete is above 50 degrees F has totaled 168 hours. Alternatively, if tests are made of cylinders kept adjacent to the structure and cured by the same methods, final curing may be terminated when the average compressive strength has reached 70 percent of the 28-day design compressive strength. Prevent rapid drying at end of final curing period.

3.10.2 Moist Curing

Remove water without erosion or damage to the structure. Prevent water run-off.

3.10.2.1 Ponding or Immersion

Continually immerse the concrete throughout the curing period. Water must not be more than 50 degrees F less than the temperature of the concrete. For temperatures between 40 and 50 degrees F, increase the curing period by 50 percent.

3.10.2.2 Fog Spraying or Sprinkling

Apply water uniformly and continuously throughout the curing period. For temperatures between 40 and 50 degrees F, increase the curing period by 50 percent.

3.10.2.3 Pervious Sheeting

Completely cover surface and edges of the concrete with two thicknesses of wet sheeting. Overlap sheeting 6 inches over adjacent sheeting. Provide sheeting that is at least as long as the width of the surface to be cured. During application, do not drag the sheeting over the finished concrete nor over sheeting already placed. Wet sheeting thoroughly and keep continuously wet throughout the curing period.

3.10.2.4 Impervious Sheeting

Wet the entire exposed surface of the concrete thoroughly with a fine spray of water and cover with impervious sheeting throughout the curing period. Lay sheeting directly on the concrete surface and overlap edges 12 inches minimum. Provide sheeting not less than 18 inches wider than the concrete surface to be cured. Secure edges and transverse laps to form closed joints. Repair torn or damaged sheeting or provide new sheeting. Cover or wrap columns, walls, and other vertical structural elements from the top down with impervious sheeting; overlap and continuously tape sheeting joints; and introduce sufficient water to soak the entire surface prior to completely enclosing.

3.10.3 Liquid Membrane-Forming Curing Compound

Seal or cover joint openings prior to application of curing compound. Prevent curing compound from entering the joint. Apply in accordance with the recommendations of the manufacturer immediately after any water sheen

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which may develop after finishing has disappeared from the concrete surface. Provide and maintain compound on the concrete surface throughout the curing period. Do not use this method of curing where the use of Figure 2.1.5 in [ACI/MCP-2](#) indicates that hot weather conditions cause an evaporation rate exceeding 0.2 pound of water per square foot per hour.

3.10.3.1 Application

Unless the manufacturer recommends otherwise, apply compound immediately after the surface loses its water sheen and has a dull appearance, and before joints are sawed. Mechanically agitate curing compound thoroughly during use. Use approved power-spraying equipment to uniformly apply two coats of compound in a continuous operation. The total coverage for the two coats must be 200 square feet maximum per gallon of undiluted compound unless otherwise recommended by the manufacturer's written instructions. The compound must form a uniform, continuous, coherent film that does not check, crack, or peel. Immediately apply an additional coat of compound to areas where the film is defective. Re-spray concrete surfaces subjected to rainfall within 3 hours after the curing compound application.

3.10.3.2 Protection of Treated Surfaces

Prohibit pedestrian and vehicular traffic and other sources of abrasion at least 72 hours after compound application. Maintain continuity of the coating for the entire curing period and immediately repair any damage.

3.10.4 Liquid Chemical Sealer-Hardener

Apply sealer-hardener to interior floors not receiving floor covering and floors located under access flooring. Apply the sealer-hardener in accordance with manufacturer's recommendations. Seal or cover joints and openings in which joint sealant is to be applied as required by the joint sealant manufacturer. Do not apply the sealer hardener until the concrete has been moist cured and has aged for a minimum of 30 days. Apply a minimum of two coats of sealer-hardener.

3.10.5 Requirements for Type III, High-Early-Strength Portland Cement

The curing periods are required to be not less than one-fourth of those specified for portland cement, but in no case less than 72 hours.

3.10.6 Curing Periods

[ACI/MCP-2](#) except 10 days for retaining walls, pavement or chimneys, 21 days for concrete that is in full-time or intermittent contact with seawater, salt spray, alkali soil or waters. Begin curing immediately after placement. Protect concrete from premature drying, excessively hot temperatures, and mechanical injury; and maintain minimal moisture loss at a relatively constant temperature for the period necessary for hydration of the cement and hardening of the concrete. The materials and methods of curing are subject to approval by the Contracting Officer.

3.10.7 Curing Methods

Accomplish curing by moist curing, by moisture-retaining cover curing, by membrane curing, and by combinations thereof, as specified.

Moist curing:

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Accomplish moisture curing by any of the following methods:

Keeping surface of concrete wet by covering with water

Continuous water spraying

Covering concrete surface with specified absorptive cover for curing concrete saturated with water and keeping absorptive cover wet by water spraying or intermittent hosing. Place absorptive cover to provide coverage of concrete surfaces and edges with a slight overlap over adjacent absorptive covers.

Moisture-cover curing:

Accomplish moisture-retaining cover curing by covering concrete surfaces with specified moisture-retaining cover for curing concrete. Place cover directly on concrete in widest practical width, with sides and ends lapped at least 3 inches. Weight cover to prevent displacement; immediately repair tears or holes appearing during curing period by patching with pressure-sensitive, waterproof tape or other approved method.

Membrane curing:

Accomplish membrane curing by applying specified membrane-forming curing compound to damp concrete surfaces as soon as moisture film has disappeared. Apply curing compound uniformly in a two-coat operation by power-spraying equipment using a spray nozzle equipped with a wind guard. Apply second coat in a direction at right angles to direction of first coat. Total coverage for two coats must be not more than 200 square feet per gallon of curing compound. Respray concrete surfaces which are subjected to heavy rainfall within 3 hours after curing compound has been applied by method and at rate specified. Maintain continuity of coating for entire curing period and immediately repair damage to coating during this period.

Membrane-curing compounds must not be used on surfaces that are to be covered with coating material applied directly to concrete or with a covering material bonded to concrete, such as other concrete, liquid floor hardener, waterproofing, dampproofing, membrane roofing, painting, and other coatings and finish materials.

3.10.8 Curing Formed Surfaces

Accomplish curing of formed surfaces, including undersurfaces of girders, beams, supported slabs, and other similar surfaces by moist curing with forms in place for full curing period or until forms are removed. If forms are removed before end of curing period, accomplish final curing of formed surfaces by any of the curing methods specified above, as applicable.

3.10.9 Curing Unformed Surfaces

Accomplish initial curing of unformed surfaces, such as monolithic slabs, floor topping, and other flat surfaces, by membrane curing.

Unless otherwise specified, accomplish final curing of unformed surfaces by any of curing methods specified above, as applicable.

Accomplish final curing of concrete surfaces to receive liquid floor

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hardener of finish flooring by moisture-retaining cover curing.

3.10.10 Temperature of Concrete During Curing

When temperature of atmosphere is 41 degrees F and below, maintain temperature of concrete at not less than 55 degrees F throughout concrete curing period or 45 degrees F when the curing period is measured by maturity. When necessary, make arrangements before start of concrete placing for heating, covering, insulation, or housing as required to maintain specified temperature and moisture conditions for concrete during curing period.

When the temperature of atmosphere is 80 degrees F and above or during other climatic conditions which cause too rapid drying of concrete, make arrangements before start of concrete placing for installation of wind breaks, of shading, and for fog spraying, wet sprinkling, or moisture-retaining covering of light color as required to protect concrete during curing period.

Changes in temperature of concrete must be uniform and not exceed 37 degrees F in any 1 hour nor 80 degrees F in any 24-hour period.

3.10.11 Protection from Mechanical Injury

During curing period, protect concrete from damaging mechanical disturbances, particularly load stresses, heavy shock, and excessive vibration and from damage caused by rain or running water.

3.10.12 Protection After Curing

Protect finished concrete surfaces from damage by construction operations.

3.11 FIELD QUALITY CONTROL

3.11.1 Sampling

ASTM C 172. Collect samples of fresh concrete to perform tests specified. ASTM C 31/C 31M for making test specimens.

3.11.2 Testing

3.11.2.1 Slump Tests

ASTM C 143/C 143M. Take concrete samples during concrete placement. The maximum slump may be increased as specified with the addition of an approved admixture provided that the water-cement ratio is not exceeded. Perform tests at commencement of concrete placement, when test cylinders are made, and for each batch (minimum) or every 20 cubic yards (maximum) of concrete.

3.11.2.2 Temperature Tests

Test the concrete delivered and the concrete in the forms. Perform tests in hot or cold weather conditions (below 50 degrees F and above 80 degrees F) for each batch (minimum) or every 20 cubic yards (maximum) of concrete, until the specified temperature is obtained, and whenever test cylinders and slump tests are made.

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3.11.2.3 Compressive Strength Tests

ASTM C 39/C 39M. Make five test cylinders for each set of tests in accordance with ASTM C 31/C 31M. Take precautions to prevent evaporation and loss of water from the specimen. Test two cylinders at 7 days, two cylinders at 28 days, and hold one cylinder in reserve. Take samples for strength tests of each mix design of concrete placed each day not less than once a day, nor less than once for each 160 cubic yards of concrete, nor less than once for each 5400 square feet of surface area for slabs or walls. For the entire project, take no less than five sets of samples and perform strength tests for each mix design of concrete placed. Each strength test result must be the average of two cylinders from the same concrete sample tested at 28 days. If the average of any three consecutive strength test results is less than f'c or if any strength test result falls below f'c by more than 450 psi, take a minimum of three ASTM C 42/C 42M core samples from the in-place work represented by the low test cylinder results and test. Concrete represented by core test is considered structurally adequate if the average of three cores is equal to at least 85 percent of f'c and if no single core is less than 75 percent of f'c. Retest locations represented by erratic core strengths. Remove concrete not meeting strength criteria and provide new acceptable concrete. Repair core holes with nonshrink grout. Match color and finish of adjacent concrete.

3.11.2.4 Air Content

ASTM C 173/C 173M or ASTM C 231 for normal weight concrete. Test air-entrained concrete for air content at the same frequency as specified for slump tests.

3.11.2.5 Strength of Concrete Structure

Compliance with the following is considered deficient if it fails to meet the requirements which control strength of structure in place, including following conditions:

Failure to meet compressive strength tests as evaluated

Reinforcement not conforming to requirements specified

Concrete which differs from required dimensions or location in such a manner as to reduce strength

Concrete curing and protection of concrete against extremes of temperature during curing, not conforming to requirements specified

Concrete subjected to damaging mechanical disturbances, particularly load stresses, heavy shock, and excessive vibration

Poor workmanship likely to result in deficient strength

3.11.2.6 Testing Concrete Structure for Strength

When there is evidence that strength of concrete structure in place does not meet specification requirements, make cores drilled from hardened concrete for compressive strength determination in accordance with ASTM C 42/C 42M, and as follows:

Take at least three representative cores from each member or area of

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concrete-in-place that is considered potentially deficient. Location of cores will be determined by the Contracting Officer.

Test cores after moisture conditioning in accordance with **ASTM C 42/C 42M** if concrete they represent is more than superficially wet under service.

Air dry cores, (**60 to 80 degrees F** with relative humidity less than 60 percent) for 7 days before test and test dry if concrete they represent is dry under service conditions.

Strength of cores from each member or area are considered satisfactory if their average is equal to or greater than 85 percent of the 28-day design compressive strength of the class of concrete.

Core specimens will be taken and tested by the Government. If the results of core-boring tests indicate that the concrete as placed does not conform to the drawings and specification, the cost of such tests and restoration required must be borne by the Contractor.

Fill core holes solid with patching mortar and finished to match adjacent concrete surfaces.

Correct concrete work that is found inadequate by core tests in a manner approved by the Contracting Officer.

3.12 JOINTS

3.12.1 Construction Joints

Make and locate joints not indicated so as not to impair strength and appearance of the structure, as approved. Locate construction joints as follows:

- a. In walls at not more than **60 feet** in any horizontal direction; at top of footing; at top of slabs on ground; at top and bottom of door and window openings or where required to conform to architectural details; and at underside of deepest beam or girder framing into wall
- b. In columns or piers, at top of footing; at top of slabs on ground; and at underside of deepest beam or girder framing into column or pier
- c. Near midpoint of spans for supported slabs, beams, and girders unless a beam intersects a girder at the center, in which case construction joints in girder must offset a distance equal to twice the width of the beam. Make transfer of shear through construction joint by use of inclined reinforcement.
- d. In slabs on ground, so as to divide slab into areas not in excess of **1,200 square feet**

Provide keyways at least **1-1/2-inches** deep in construction joints in walls and slabs and between walls and footings; approved bulkheads may be used for slabs.

Joints must be perpendicular to main reinforcement. Reinforcement must be continued across construction joints.

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3.12.2 Isolation Joints in Slabs on Ground

Provide joints at points of contact between slabs on ground and vertical surfaces, such as column pedestals, foundation walls, grade beams, and elsewhere as indicated.

Fill joints with premolded joint filler strips 1/2 inch thick, extending full slab depth. Install filler strips at proper level below finish floor elevation with a slightly tapered, dress-and-oiled wood strip temporarily secured to top of filler strip to form a groove not less than 3/4 inch in depth where joint is sealed with sealing compound and not less than 1/4 inch in depth where joint sealing is not required. Remove wood strip after concrete has set. Contractor must clean groove of foreign matter and loose particles after surface has dried.

3.12.3 Control Joints in Slabs on Ground

Provide joints to form panels as indicated.

Under and on exact line of each control joint, cut 50 percent of welded wire fabric reinforcement before placing concrete.

Joints must be 1/8-inch wide by 1/5 to 1/4 of slab depth and formed by inserting hand-pressed fiberboard strip into fresh concrete until top surface of strip is flush with slab surface or by cutting the concrete with a saw after the concrete has set. After concrete has cured for at least 7 days, the Contractor must remove inserts and clean groove of foreign matter and loose particles.

3.12.4 Sealing Joints in Slabs on Ground

Isolation and control joints which are to receive finish flooring material must be sealed with joint sealing compound after concrete curing period. Slightly underfill groove with joint sealing compound to prevent extrusion of compound. Remove excess material as soon after sealing as possible.

Sealing is not required for isolation and control joints to be covered with finish flooring material. Groove must be left ready to receive filling material that is provided as part of finish floor covering work.

3.13 INSTALLATION OF ANCHORAGE DEVICES

3.13.1 General

Anchorage devices and embedded items required for other work that is attached to, or supported by, set and build in cast-in-place concrete as part of the work of this section, using setting drawings, instructions, and directions for work to be attached thereto.

3.13.2 Placing Anchorage Devices

Anchorage devices and embedded items must be positioned accurately and supported against displacement. Fill openings in anchorage devices such as slots and threaded holes with an approved, removable material to prevent entry of concrete into openings.

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3.14 CONCRETE CONVEYING

3.14.1 Transfer of Concrete At Project Site

Handle concrete from point of delivery and transfer to concrete conveying equipment and to locations of final deposit as rapidly as practical by methods which prevent segregation and loss of concrete mix materials.

3.14.2 Mechanical Equipment for Conveying Concrete

Equipment must ensure a continuous flow of concrete at delivery end, as approved. Provide runways for wheeled concrete-conveying equipment from concrete delivery point to locations of final deposit. Interior surfaces of concrete conveying equipment must be free of hardened concrete, debris, water, snow, ice, and other deleterious substances.

-- End of Section --

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SECTION 03 40 00.00 10

PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION 08/06

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ACI INTERNATIONAL (ACI)

- | | |
|--------------|---|
| ACI 211.1 | (1991; R 2002) Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete |
| ACI 211.2 | (1998; R 2004) Standard Practice for Selecting Proportions for Structural Lightweight Concrete |
| ACI 305R | (1999; Errata 2006) Hot Weather Concreting |
| ACI 306.1 | (1990; R 2002) Standard Specification for Cold Weather Concreting |
| ACI 318/318R | (2005; Errata 2005) Building Code Requirements for Structural Concrete and Commentary |

AMERICAN CONCRETE PIPE ASSOCIATION (ACPA)

- | | |
|-------------|---|
| ACPA 01-102 | (2000) Concrete Pipe Handbook |
| ACPA 01-110 | (1984) Design Manual for Sulfide and Corrosion Prediction and Control |
| ACPA QPC | (2005; Ver 3.0) QCast Plant Certification Manual |

AMERICAN WELDING SOCIETY (AWS)

- | | |
|----------------|---|
| AWS D1.1/D1.1M | (2006; Errata 2006) Structural Welding Code - Steel |
| AWS D1.4/D1.4M | (2005; Errata 2005) Structural Welding Code - Reinforcing Steel |

ASTM INTERNATIONAL (ASTM)

- | | |
|-------------------|---|
| ASTM A 153/A 153M | (2005) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware |
| ASTM A 185/A 185M | (2007) Standard Specification for Steel |

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	Welded Wire Reinforcement, Plain, for Concrete
ASTM A 36/A 36M	(2005) Standard Specification for Carbon Structural Steel
ASTM A 496/A 496M	(2007) Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement
ASTM A 497/A 497M	(2007) Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete
ASTM A 615/A 615M	(2007) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A 706/A 706M	(2006a) Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A 767/A 767M	(2005) Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement
ASTM A 775/A 775M	(2007b) Standard Specification for Epoxy-Coated Steel Reinforcing Bars
ASTM A 82/A 82M	(2007) Standard Specification for Steel Wire, Plain, for Concrete Reinforcement
ASTM A 884/A 884M	(2006) Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement
ASTM C 1064/C 1064M	(2005) Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
ASTM C 1107/C 1107M	(2007a) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM C 1240	(2005) Standard Specification for Silica Fume Used in Cementitious Mixtures
ASTM C 1244	(2005a; E 2006) Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill
ASTM C 138/C 138M	(2007) Standard Test Method for Density ("Unit Weight"), Yield, and Air Content (Gravimetric) of Concrete
ASTM C 143/C 143M	(2005a) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C 1478	(2007) Standard Specification for Storm

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Drain Resilient Connectors Between
Reinforced Concrete Storm Sewer
Structures, Pipes and Laterals

ASTM C 150	(2007) Standard Specification for Portland Cement
ASTM C 171	(2007) Standard Specification for Sheet Materials for Curing Concrete
ASTM C 173/C 173M	(2007) Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C 192/C 192M	(2007) Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
ASTM C 231	(2004) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 260	(2006) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C 309	(2007) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C 31/C 31M	(2006) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C 33	(2003) Standard Specification for Concrete Aggregates
ASTM C 330	(2005) Standard Specification for Lightweight Aggregates for Structural Concrete
ASTM C 39/C 39M	(2005e1) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C 443	(2005a) Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
ASTM C 494/C 494M	(2005a) Standard Specification for Chemical Admixtures for Concrete
ASTM C 595	(2007) Standard Specification for Blended Hydraulic Cements
ASTM C 618	(2005) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C 877	(2002; E 2005) External Sealing Bands for Concrete Pipe, Manholes, and Precast Box

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Sections

ASTM C 891	(1990; R 2003) Installation of Underground Precast Concrete Utility Structures
ASTM C 920	(2005) Standard Specification for Elastomeric Joint Sealants
ASTM C 923	(2007) Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals
ASTM C 989	(2006) Standard Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars
ASTM C 990	(2006) Standard Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections Using Preformed Flexible Joint Sealants

CSA AMERICA, INC. (CSA/AM)

CAN/CSA A23.4	(2005) Precast Concrete - Materials and Construction
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NATIONAL PRECAST CONCRETE ASSOCIATION (NPCA)

NPCA QC Manual	(2005; R 2006) Quality Control Manual for Precast Plants
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1.2 SUBMITTALS

All submittals are the responsibility of the precast concrete producer. Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Standard Precast Units

Drawings for standard precast concrete units furnished by the precast concrete producer for approval by the Contracting Officer. These drawings shall demonstrate that the applicable industry design standards have been met. Include installation and construction information on shop drawings. Include details of steel reinforcement size and placement as well as supporting design calculations, if appropriate. Produce precast concrete units in accordance with the approved drawings.

Custom-Made Precast Units

Drawings for custom-made precast concrete units furnished by the precast concrete producer for approval by the Contracting Officer. Show on these drawings complete design, installation,

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and construction information in such detail as to enable the Contracting Officer to determine the adequacy of the proposed units for the intended purpose. Include details of steel reinforcement size and placement as well as supporting design calculations, if appropriate. Produce precast concrete units in accordance with the approved drawings.

SD-03 Product Data

Standard Precast Units

Cut sheets, for standard precast concrete units, showing conformance to project drawings and requirements, and to applicable industry design standards listed in this specification.

Proprietary Precast Units

Standard plans or informative literature, for proprietary precast concrete units. Make available supporting calculations and design details upon request. Provide sufficient information as to demonstrate that such products will perform the intended task.

Embedded Items

Product data sheets and proper installation instruction for anchors, lifting inserts and other devices. Clearly indicate the products dimensions and safe working load.

Accessories

Proper installation instructions and relevant product data for items including, but not limited to, sealants, gaskets, connectors, steps, cable racks and other items installed before or after delivery.

SD-05 Design Data

Design Calculations Concrete Mix Proportions

Precast concrete unit design calculations, and concrete mix proportions.

SD-06 Test Reports

Test Reports Quality Control Procedures

1.3 GENERAL REQUIREMENTS

Furnish precast concrete units designed and fabricated by an experienced and acceptable precast concrete manufacturer who has been, for at least 3 years, regularly and continuously engaged in the manufacture of precast concrete work similar to that indicated on the drawings. Coordinate precast work with the work of other trades.

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1.4 DESIGN

1.4.1 Standard Precast Units

Design standard precast concrete units to withstand indicated design load conditions in accordance with applicable industry design standards [ACI 318/318R](#), ASTM, [ACPA 01-102](#), Chapter 7-Design for Sulfide Control. Design must also consider stresses induced during handling, shipping and installation as to avoid product cracking or other handling damage. Indicate design loads for precast concrete units on the shop drawings.

1.4.2 Custom-Made Precast Units

Submit [design calculations](#) and drawings of custom-made precast units, prepared and sealed by a registered professional engineer, for approval prior to fabrication. Include in the calculations the analysis of units for lifting stresses and the sizing of lifting devices.

1.4.3 Proprietary Precast Units

Products manufactured under franchise arrangements must conform to all the requirements specified by the franchiser. Items not included in the franchise specification, but included in this specification, must conform to the requirements in this specification.

1.4.4 Joints and Sealants

Provide joints and sealants between adjacent units of the type and configuration indicated on shop drawings meeting specified design and performance requirements.

1.4.5 Concrete Mix Design

1.4.5.1 Concrete Mix Proportions

Base selection of proportions for concrete on the methodology presented in [ACI 211.1](#) for normal weight concrete and [ACI 211.2](#) for lightweight concrete. Develop the concrete proportions using the same type and brand of cement, the same type and brand of pozzolan, the same type and gradation of aggregates, and the same type and brand of admixture that will be used in the manufacture of precast concrete units for the project. Do not use calcium chloride in precast concrete containing reinforcing steel or other embedded metal items. At a minimum of thirty days prior to precast concrete unit manufacturing, the precast concrete producer will submit a mix design for each strength and type of concrete that will be used. Furnish a complete list of materials, including quantity, type, brand and applicable data sheets for all mix design constituents as well as applicable reference specifications. The use of self-consolidating concrete is permitted, provided that mix design proportions and constituents meet the requirements of this specification.

1.4.5.2 Concrete Strength

Provide precast concrete units with a 28-day compressive strength (f'_c) of 3000 [psi](#).

1.4.5.3 Water-to-Cement Ratio

Furnish concrete, that will be exposed to freezing and thawing, containing

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entrained air and with water-cement ratios of 0.45 or less. Furnish concrete which will not be exposed to freezing, but which is required to be watertight, with a water-cement ratio of 0.48 or less if the concrete is exposed to fresh water, or 0.45 or less if exposed to brackish water or sea water. Furnish reinforced concrete exposed to deicer salts, brackish water or seawater with a water-cement ratio of 0.40 or less for corrosion protection.

1.4.5.4 Air Content

The air content of concrete that will be exposed to freezing conditions must be within the limits given below.

NOMINAL MAXIMUM AGGREGATE SIZE	AIR CONTENT %	
	SEVERE EXPOSURE	MODERATE EXPOSURE
10 mm (3/8 inch)	6.0 to 9.0	4.5 to 7.5
13 mm (1/2 inch)	5.5 to 8.5	4.0 to 7.0
19 mm (3/4 inch)	4.5 to 7.5	3.5 to 6.5
25 mm (1.0 inch)	4.5 to 7.5	3.0 to 6.0
38 mm (1.5 inch)	4.5 to 7.0	3.0 to 6.0

Note: For specified compressive strengths greater than 5000 psi, air content may be reduced 1%

1.4.5.5 Corrosion Control for Sanitary Sewer Systems

Follow design recommendations outlined in Chapter 7 of [ACPA 01-102](#) or the [ACPA 01-110](#) when hydrogen sulfide is indicated as a potential problem.

1.5 QUALITY ASSURANCE

Demonstrate adherence to the standards set forth in [NPCA QC Manual](#) and/or [ACPA QPC](#). Meet requirements written in the subparagraphs below.

1.5.1 NPCA and ACPA Plant Certification

The precast concrete producer shall be certified by the National Precast Concrete Association's and/or the American Concrete Pipe Association's Plant Certification Program prior to and during production of the products for this project.

1.5.2 Qualifications, Quality Control and Inspection

1.5.2.1 Qualifications

Select a precast concrete producer that has been in the business of producing precast concrete units similar to those specified for a minimum of 3 years. The precast concrete producer must maintain a permanent quality control department or retain an independent testing agency on a continuing basis.

1.5.2.2 Quality Control Procedures

Show that the following QC tests are performed as required and in accordance with the ASTM standards indicated.

- a. Slump: Perform a slump test for each 150 cu yd of concrete produced, or once a day, whichever comes first. Perform slump tests in

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accordance with ASTM C 143/C 143M.

b. Temperature: Measure the temperature of fresh concrete when slump or air content tests are made and when compressive test specimens are made in accordance with ASTM C 1064/C 1064M.

c. Compressive Strength: Make at least four compressive strength specimens for each 150 cubic yards of concrete of each mix in accordance with the following Standards: ASTM C 31/C 31M, ASTM C 192/C 192M, ASTM C 39/C 39M.

d. Air Content: Perform tests for air content on air-entrained, wet-cast concrete for each 150 cu yd of concrete, but not less often than once each day when air-entrained concrete is used. Determine the air content in accordance with either ASTM C 231 or ASTM C 173/C 173M for normal weight aggregates and ASTM C 173/C 173M for lightweight aggregates.

e. Unit Weight: Perform tests for unit weight a minimum of once per week to verify the yield of batch mixes. Perform unit weight tests for each 100 cu yd of lightweight concrete in accordance with ASTM C 138/C 138M.

Submit test reports as specified in the Submittals paragraph and documentation to demonstrate compliance with the above subparagraphs.

1.5.2.3 Inspection

The Contracting Officer may place an inspector in the plant when the units covered by this specification are being manufactured. The burden of payment for plant inspection will be clearly detailed in the specification. The precast concrete producer shall give notice 14 days prior to the time the units will be available for plant inspection. Neither the exercise nor waiver of inspection at the plant will affect the Government's right to enforce contractual provisions after units are transported or erected.

1.6 HANDLING, STORAGE AND DELIVERY

1.6.1 Handling

Handle, transport, and store products in a manner to minimize damage. Lifting devices or holes shall be consistent with industry standards. Perform lifting with methods or devices intended for this purpose as indicated on shop drawings.

1.6.2 Storage

Store units off the ground or in a manner that will minimize potential damage.

1.6.3 Delivery

Deliver precast units to the site in accordance with the delivery schedule to avoid excessive build-up of units in storage at the site. Upon delivery to the jobsite, all precast concrete units will be inspected by the Contracting Officer for quality and final acceptance.

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PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Cement

Furnish cement conforming to [ASTM C 150](#), Type I, II, III or V. Furnish blended cements that conform to [ASTM C 595](#).

2.1.2 Silica Fume

Provide silica fume conforming to [ASTM C 1240](#). Provide available alkalies conforming to the optimal limit given in Table 2 of [ASTM C 1240](#). Silica fume may be furnished as a dry, densified material or as a slurry. When necessary, coordinate the services of a technical representative experienced in mixing, proportioning, placement procedures, and curing of concrete containing silica fume.

2.1.3 Fly Ash and Pozzolans

Fly ash is used as an admixture conforming to [ASTM C 618](#), Class C or F with 4 percent maximum loss on ignition and 35 percent maximum cement replacement by weight.

2.1.4 Ground Granulated Blast-Furnace Slag

Ground granulated blast furnace slag is used as an admixture conforming to [ASTM C 989](#), Grade 120 with between 25 to 50 percent maximum cement replacement by weight.

2.1.5 Water

Furnish water potable or free of deleterious substances in amounts harmful to concrete or embedded metals.

2.1.6 Aggregates

2.1.6.1 Selection

Furnish aggregates conforming to [ASTM C 33](#). Provide aggregates not containing any substance, which may be deleteriously reactive with the alkalies in the cement.

2.1.6.2 Aggregates for Lightweight Concrete

[ASTM C 330](#)

2.1.7 Admixtures

2.1.7.1 Air-Entraining

[ASTM C 260](#)

2.1.7.2 Accelerating, Retarding, Water Reducing Moderate to High

[ASTM C 494/C 494M](#)

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2.1.7.3 Pigments

Non-fading and lime-resistant

2.1.8 Reinforcement

2.1.8.1 Reinforcing Bars

- a. Deformed Billet-steel: [ASTM A 615/A 615M](#)
- b. Deformed Low-alloy steel: [ASTM A 706/A 706M](#)

2.1.8.2 Reinforcing Wire

- a. Plain Wire: [ASTM A 82/A 82M](#)
- b. Deformed Wire: [ASTM A 496/A 496M](#)

2.1.8.3 Welded Wire Fabric

- a. Plain Wire: [ASTM A 185/A 185M](#)
- b. Deformed Wire: [ASTM A 497/A 497M](#)

2.1.8.4 Epoxy Coated Reinforcement

- a. Reinforcing Bars: [ASTM A 775/A 775M](#)
- b. Wires and Fabric: [ASTM A 884/A 884M](#)

2.1.8.5 Galvanized Reinforcement

Provide galvanized reinforcement conforming to [ASTM A 767/A 767M](#).

2.1.9 Synthetic Fiber Reinforcement

Synthetic fiber shall be polypropylene with a denier less than 100 and a nominal fiber length of [2 inch](#).

2.1.10 Inserts and Embedded Metal

All items embedded in concrete shall be of the type required for the intended task, and meet the following standards.

- a. Structural Steel Plates, Angles, etc.: [ASTM A 36/A 36M](#)
- b. Hot-dipped Galvanized: [ASTM A 153/A 153M](#)
- c. Proprietary Items: In accordance with manufacturers published literature

2.1.11 [Accessories](#)

- a. Rubber Gaskets for Circular Concrete Sewer Pipe and Culvert Pipe: [ASTM C 443](#).
- b. External Sealing Bands for Noncircular Sewer, Storm Drain and Culvert Pipe: [ASTM C 877](#).
- c. Preformed Flexible Joint Sealants for Concrete Pipe, Manholes, and Manufactured Box Sections: [ASTM C 990](#).
- d. Elastomeric Joint Sealants: [ASTM C 920](#)

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2.1.12 Pipe Entry Connectors

Pipe entry connectors shall conform to [ASTM C 923](#) or [ASTM C 1478](#).

2.1.13 Grout

Nonshrink Grout shall conform to [ASTM C 1107/C 1107M](#). Cementitious grout shall be a mixture of portland cement, sand, and water. Proportion one part cement to approximately 2.5 parts sand, with the amount of water based on placement method. Provide air entrainment for grout exposed to the weather.

PART 3 EXECUTION

3.1 FABRICATION AND PLACEMENT

Perform fabrication in accordance with [NPCA QC Manual](#) and/or [ACPA QPC](#) unless specified otherwise.

3.1.1 Forms

Use forms, for manufacturing precast concrete products, of the type and design consistent with industry standards and practices. They should be capable of consistently providing uniform products and dimensions. Construct forms so that the forces and vibrations to which the forms will be subjected can cause no product damage. Clean forms of concrete build-up after each use. Apply form release agents according to the manufacturers recommendations and do not allow to build up on the form casting surfaces.

3.1.2 Reinforcement

Follow applicable ASTM Standard or [ACI 318/318R](#) for placement and splicing. Fabricate cages of reinforcement either by tying the bars, wires or welded wire fabric into rigid assemblies or by welding, where permissible, in accordance with [AWS D1.4/D1.4M](#). Position reinforcing as specified by the design and so that the concrete cover conforms to requirements. The tolerance on concrete cover shall be one-third of that specified but not more than [1/2 inch](#). Provide concrete cover not less than [1/2 inch](#). Take positive means to assure that the reinforcement does not move significantly during the casting operations.

3.1.3 Embedded Items

Position embedded items at locations specified in the design documents. Perform welding in accordance with [AWS D1.1/D1.1M](#) when necessary. Hold rigidly in place inserts, plates, weldments, lifting devices and other items to be imbedded in precast concrete products so that they do not move significantly during casting operations.

3.2 CONCRETE

3.2.1 Concrete Mixing

Mixing operations shall produce batch-to-batch uniformity of strength, consistency, and appearance.

3.2.2 Concrete Placing

Deposit concrete into forms as near to its final location as practical.

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Keep the free fall of the concrete to a minimum. Consolidate concrete in such a manner that segregation of the concrete is minimized and honeycombed areas are kept to a minimum. Use vibrators to consolidate concrete with frequencies and amplitudes sufficient to produce well consolidated concrete.

3.2.2.1 Cold Weather Concreting

Perform cold weather concreting in accordance with [ACI 306.1](#).

- a. Provide adequate equipment for heating concrete materials and protecting concrete during freezing or near-freezing weather.
- b. Free from frost all concrete materials and all reinforcement, forms, fillers, and ground with which concrete is to come in contact.
- c. Do not use frozen materials or materials containing ice.
- d. In cold weather the temperature of concrete at the time of placing shall not be below [45 degrees F](#). Discard concrete that freezes before its compressive strength reaches [500 psi](#).

3.2.2.2 Hot Weather Concreting

Recommendations for hot weather concreting are given in detail in [ACI 305R](#). During hot weather, give proper attention to constituents, production methods, handling, placing, protection, and curing to prevent excessive concrete temperatures or water evaporation that could impair required strength or serviceability of the member or structure. The temperature of concrete at the time of placing shall not exceed [90 degrees F](#).

3.2.3 Concrete Curing

Commence curing immediately following the initial set and completion of surface finishing.

3.2.3.1 Curing by Moisture Retention

Prevent moisture evaporation from exposed surfaces until adequate strength for stripping is reached by one of the following methods:

- a. Cover with polyethylene sheets a minimum of [6 mils](#) thick per [ASTM C 171](#).
- b. Cover with burlap or other absorptive material and keep continually moist.
- c. Use of a membrane-curing compound applied at a rate not to exceed [200 square ft/gallon](#), or per manufacturers' recommendations according to [ASTM C 309](#).

3.2.3.2 Curing with Heat and Moisture

Do not subject concrete to steam or hot air until after the concrete has attained its initial set. Apply steam, if used, within a suitable enclosure, which permits free circulation of the steam in accordance with [CAN/CSA A23.4](#). If hot air is used for curing, take precautions to prevent moisture loss from the concrete. The temperature of the concrete shall not be permitted to exceed [150 degrees F](#). These requirements do not apply to products cured with steam under pressure in an autoclave.

3.2.4 Surface Finish

Finish unformed surfaces of wet-cast precast concrete products as specified. If no finishing procedure is specified, finish such surfaces using a strike-off to level the concrete with the top of the form.

3.2.4.1 Formed Non-Architectural Surfaces

Cast surfaces against approved forms following industry practices in cleaning forms, designing concrete mixes, placing and curing concrete. Normal color variations, form joint marks, small surface holes caused by air bubbles, and minor chips and spalls will be accepted but no major imperfections, honeycombs or other major defects will be permitted.

3.2.4.2 Unformed Surfaces

Finish unformed surfaces with a vibrating screed, or by hand with a float. Normal color variations, minor indentations, minor chips and spalls will be accepted but no major imperfections, honeycombs, or other major defects shall be permitted.

3.2.4.3 Special Finishes

Troweled, broom or other finishes shall be according to the requirements of project documents and performed per industry standards or supplier specifications. Submit finishes for approval when required by the project documents. The sample finishes shall be approved prior to the start of production.

3.2.5 Stripping Products from Forms

Do not remove products from the forms until the concrete reaches the compressive strength for stripping required by the design. If no such requirement exists, products may be removed from the forms after the final set of concrete provided that stripping damage is minimal.

3.2.6 Patching and Repair

No repair is required to formed surfaces that are relatively free of air voids and honeycombed areas, unless the surfaces are required by the design to be finished.

3.2.6.1 Repairing Minor Defects

Defects that will not impair the functional use or expected life of a precast concrete product may be repaired by any method that does not impair the product.

3.2.6.2 Repairing Honeycombed Areas

When honeycombed areas are to be repaired, remove all loose material and cut back the areas into essentially horizontal or vertical planes to a depth at which coarse aggregate particles break under chipping rather than being dislodged. Use proprietary repair materials in accordance with the manufacturer's instructions. If a proprietary repair material is not used, saturate the area with water. Immediately prior to repair, the area should be damp, but free of excess water. Apply a cement-sand grout or an approved bonding agent to the chipped surfaces, followed immediately by

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consolidating an appropriate repair material into the cavity.

3.2.6.3 Repairing Major Defects

Evaluate, by qualified personnel, defects in precast concrete products which impair the functional use or the expected life of products to determine if repairs are feasible and, if so, to establish the repair procedure.

3.2.7 Shipping Products

Do not ship products until they are at least 5 days old, unless it can be shown that the concrete strength has reached at least 75% of the specified 28-day strength, or that damage will not result, impairing the performance of the product.

3.3 INSTALLATION

3.3.1 Site Access

It is the Contractor's responsibility to provide adequate access to the site to facilitate hauling, storage and proper handling of the precast concrete products.

3.3.2 General Requirements

- a. Install precast concrete products to the lines and grades shown in the contract documents or otherwise specified.
- b. Lift products by suitable lifting devices at points provided by the precast concrete producer.
- c. Install products per the precast concrete producer's instructions. In the absence of such instructions, install underground utility structures in accordance with [ASTM C 891](#). Install pipe and manhole sections in accordance with the procedures outlined by the American Concrete Pipe Association.
- d. Field modifications to the product will relieve the precast producer of liability even if such modifications result in the failure of the product.

3.3.3 Water Tightness

Where water tightness is a necessary performance characteristic of the precast concrete product's end use, watertight joints, connectors and inserts should be used to ensure the integrity of the entire system.

3.4 FIELD QUALITY CONTROL

3.4.1 Site Tests

When water tightness testing is required for an underground product, use one of the following methods:

3.4.2 Vacuum Testing

Prior to backfill vacuum test system according to [ASTM C 1244](#).

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3.4.3 Water Testing

Perform water testing according to the contract documents and precast concrete producer's recommendations.

-- End of Section --

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GENERAL MECHANICAL PROVISIONS

04/06

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A 123/A 123M (2002) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 82 Protection of Stratospheric Ozone

UNDERWRITERS LABORATORIES (UL)

UL 2001 (2001) Building Materials Directory

1.2 SUBMITTALS

NOT USED

1.3 APPLICABILITY

This section shall apply to, and be a component part of, each section that is a part of Division 15, "Mechanical".

1.4 SCOPE OF WORK

The Contractor shall furnish all labor, materials, equipment, calculations, and services to construct, install, and test the complete mechanical systems and related work, indicated and specified.

1.5 INTERPRETATION OF DRAWINGS AND SPECIFICATIONS

It is the intent of these specifications and the contract drawings to provide a complete and workable facility.

Design drawings are diagrammatic and do not show all offsets, bends, elbows or other specific elements which may be required for proper installation of the work. Such work shall be verified at the site. Additional bends and offsets as required by vertical and horizontal equipment locations or other job conditions shall be provided to complete the work, at no additional cost to the Government.

Except where shown in dimensional detail, the locations of piping, and fittings are only approximate; the exact locations shall be determined by the Contractor, subject to approval by the COTR.

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1.6 CODES AND STANDARDS

Design, fabrication, testing, installation, and system performance shall, unless shown or specified otherwise, comply with the referenced publications to the extent indicated by the references thereto. No equipment or piping, including soldered joints, containing lead shall be installed in potable water systems.

1.7 COORDINATION

Contractor shall coordinate the work of the different trades so that interference between piping, equipment, structural, and electrical work will be avoided. All necessary offsets in piping and ductwork, and all fittings, etc., required to install the work properly shall be furnished complete in place at no additional cost to the Government.

1.8 MECHANICAL SYSTEMS IDENTIFICATION

1.8.1 General

The Contractor shall provide a coordinated system of piping identification which includes:

Valves and components shall have a tag to identify the device and system it is installed. Tag engraving shall be as detailed in paragraph "System Component Tags".

Piping identification and color coding as per paragraph "Service Labeling".

The Contractor shall submit the entire identification system for approval prior to proceeding with the work.

1.8.2 System Component Tags

Laminated Plastic Tags:

Identification tags shall be made of laminated plastic. The tag's engraved letters/ numbers shall be black with background color the color listed under color bands under paragraph entitled "Service Labeling". On brown colored tags, provide white letters/numbers.

Tags shall be rectangular 0.125 inch (3 mm) thick, 1.500 inch (38 mm) width by 5.750 inch (146 mm) length for two letter-number rows. The upper row shall indicate the components prefix number. The lower row shall indicate the systems index number for the component. The upper row shall be 0.250 inch (6 mm) from the top beginning 0.750 inch (19 mm) from left end with 0.500 inch (13 mm) by 0.500 inch (13 mm) by 0.125 inch (6 mm) thick block letter-numbers on 0.250 inch (6 mm) spacing with 0.500 inch (13 mm) space between letters and numbers ending 0.500 inch (13 mm) from right end. The lower row shall be 0.250 inch (6 mm) from bottom, 0.250 inch (6 mm) by 0.250 inch (6 mm) by 0.0625 inch (2 mm) thick block letters positioned under the upper row. The left end of the tag shall have a 0.250 inch (6 mm) hole centered in the 0.750 inch (19 mm) by 1.500 inch (38 mm) area for wiring to component.

Tags shall be wired to valve or component items with No. 12 AWG (3 mm) diameter stainless steel wire. Care shall be taken when installing the

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tags so that valves are not damaged (softened) by hot objects.

All components shall be provided with identification tags displaying the numbers assigned by the COTR. At the completion of the job, a list of all component numbers used, along with a description of component identified, shall be provided.

Metal Tags

Identification tags made of brass or aluminum and indicating function of valve or similar component, shall be installed on such system devices. Tags shall be not less than 50 millimeter in diameter and marking shall be stamped

Tags shall be secured to valve or equipment items with 2.7 millimeter galvanized wire.

1.8.3 Service Labeling

All piping including that concealed in accessible spaces; exposed, bare and painted shall be labeled to designate service. Each label shall include an arrow or arrows to indicate flow direction and a color warning band. Labels and system component tag color scheme shall be in accordance with the schedule on drawings.

Similar services with different temperatures or pressures shall be identified. Where pressures may exceed 125 pounds per square inch, gage, the maximum system pressure shall be included in the label.

Piping shall be labeled and arrowed in accordance with the following:

Each change in direction, i.e., elbows, tees

In congested or hidden areas and at all access points required to clarify service or indicated hazard.

In long straight runs, labels shall be located at distances within eyesight of each other but in no case shall the distance between labels exceed 250 feet. All labels shall be visible and legible from the primary service and operating area.

The label and system component tag schedule above shall not be construed as defining or limiting the work.

Preprinted legends such as decalcomanias, snap-on, tie-on, or pressure secured are commercially available and shall be used with approval of the COTR. The color band shall be used to secure each end of label. When such legends are used their fabrication and application must be suitable for the environment in which they are used. Background and letter-numerals, style, size, and color scheme shall match the requirements listed in paragraph "Service Labeling."

1.9 APPROVAL REQUIREMENTS

Except as otherwise specified, approval of materials and equipment will be based on manufacturer's published data.

Where materials and equipment are specified to conform to the standards of the Underwriters Laboratories, the label of or listing with reexamination

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in [UL 2001](#) will be acceptable as sufficient evidence that the items conform to Underwriters Laboratories requirements. In lieu of such label or listing, the Contractor may submit a written certificate from any nationally recognized testing agency, adequately equipped and competent to perform such services, stating that the items have been tested and that the units conform to the specified requirements. Methods of testing used by the specified agencies shall be outlined.

Where materials or equipment are specified to be constructed or tested, or both, in accordance with the standards of the American Society for Testing and Materials (ASTM), the American Society of Mechanical Engineers (ASME), or other standards, a manufacturer's certificate of compliance of each item will be acceptable as proof of compliance.

Conformance to such agency requirements does not relieve the item from compliance with other requirements of these specifications.

1.10 STORAGE AND PROTECTION OF MATERIALS

All materials stored at the site shall be fully protected from damage, dirt, debris, and weather.

1.11 PREVENTION OF CORROSION

Metallic materials shall be protected against corrosion. Equipment enclosures shall be given rust-inhibiting treatment and standard finish by the manufacturer. Aluminum shall not be used in contact with earth, and where connected to dissimilar metal, shall be protected by approved fittings, barrier material, or treatment. Ferrous parts such as anchors, bolts, braces, boxes, bodies, clamps, fittings, guards, nuts, pins, rods, shims, thimbles, washers, and miscellaneous parts not of corrosion-resistant steel or nonferrous materials shall be hot-dip galvanized in accordance with [ASTM A 123/A 123M](#) for exterior locations.

1.12 OZONE DEPLETING SUBSTANCES USED AS REFRIGERANTS

Releases of Ozone Depleting Substances (ODS) during repair, maintenance, servicing or disposal of appliances containing ODS's will be minimized by complying with all applicable sections of [40 CFR 82](#) Part 82 Subpart F. Any person conducting repair, maintenance, servicing or disposal of appliances owned by NASA comply with the following:

No Class I or Class II substances used as a refrigerant may be knowingly vented or otherwise released into the environment.

No appliances may be opened without meeting the requirements of [40 CFR 82](#) Part 82.156 Subpart F, regarding required practices regarding evacuation and collection of refrigerant, and [40 CFR 82](#) Part 82.158 Subpart F, regarding standards of recycling and recovery equipment.

No work may be conducted on appliances containing refrigerant except by persons who comply with [40 CFR 82](#) Part 82.161 Subpart F, regarding technician certification.

In addition, copies of all applicable certifications must be provided to the Contracting Officer at least 10 working days prior to initiating maintenance, repair, servicing, dismantling or disposal of appliances, including:

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Proof of Technician Certification

Proof of Equipment Certification, if recovery or recycling equipment is to be provided by the Contractor

Proof of availability of certified recovery or recycling equipment, if equipment is to be provided by the Contractor

1.13 USE OF OZONE DEPLETING SUBSTANCES, OTHER THAN REFRIGERANTS

The use of Class I or Class II ODS's listed as nonessential in 40 CFR 82 Part 82.66 Subpart C is prohibited. These prohibited materials and uses include:

Any plastic party spray streamer or noise horn which is propelled by a chlorofluorocarbon

Any cleaning fluid for electronic and photographic equipment which contains a chlorofluorocarbon; including liquid packaging, solvent wipes, solvent sprays, and gas sprays

Any plastic flexible or packaging foam product which is manufactured with or contains a chlorofluorocarbon, including, open cell foam, open cell rigid polyurethane poured foam, closed cell extruded polystyrene sheet foam, closed cell polyethylene foam and closed cell polypropylene foam except for flexible or packaging foam used in coaxial

Any aerosol product or other pressurized dispenser which contains a chlorofluorocarbon, except for those listed in 40 CFR 82 Part 82.66 Subpart C.

A waiver may be requested should a programmatic of facility requirement dictate that a prohibited material is necessary to achieve project goals. A waiver request must be submitted in writing to the Test Operations and Institutional Safety Branch. The waiver will be evaluated and dispositioned by a Hazardous Material Review Subcommittee.

1.14 RECORD DRAWINGS AND MANUALS

The Contractor shall provide, and keep up-to-date, a complete record set of drawings which shall be corrected to show every change from the original specification and drawings. Prints for this purpose may be obtained from the COTR. This set of prints shall be kept on the jobsite and shall be used only as a record set. This shall not be construed as authorization for the Contractor to make changes in the layout or specification without approval. Upon completion of the work and before final payment, the record set of drawings and manuals shall be submitted for approval. Upon approval, the record set of drawings and all manuals will be retained by the COTR.

Manuals shall be bound in a loose leaf, 3-ring binder with index tabs separating and identifying equipment. The manual shall contain copies of controls and major equipment and shall be marked to indicate brand and model furnished with capacity data, parts lists, wiring diagrams, operating and maintenance information, and air/water balancing data. Number of copies shall be the same as for submittals or six (6) minimum.

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PART 2 PRODUCTS

2.1 MATERIAL

Mechanical material shall meet the requirements indicated and specified and shall be designed for the installation shown. All components bearing the same part number shall be identical in form, fit, and function. All materials and equipment shall be new and free from defects. Any metal exposed to the weather shall be fabricated of aluminum or stainless steel (including bolts, nuts, fasteners, supports and ductwork).

2.2 PAINTING

All exposed piping (not insulated), tubing, and device installed under this contract and exposed to view abovegrade shall be painted. See specifications or drawings for painting of piping.

2.3 VALVES AND FITTINGS

Ductile or malleable iron, bronze or brass are acceptable for other piping systems with copper acceptable for water piping systems.

PART 3 EXECUTION

3.1 INSTALLATION

Materials shall be installed in accordance with the requirements of the contract drawings and approved recommendations of the manufacturers. Installation shall be accomplished by workers skilled in this type of work.

3.2 CLEANING

After piping has been pressure tested and prior to placing systems in operation, all piping and fittings shall be flushed to remove any dirt, grit, rust, scale, grease, oil, or other materials. Water for flushing will be furnished by the Government; but, flushing shall be accomplished in such a manner as to prevent undue water waste.

3.3 HYDROSTATIC TESTING

3.3.1 General

These guidelines shall be followed for testing systems, that can be filled with a fluid, designed for liquid, gas, or steam.

These guidelines are based on the requirements of the ASME and ANSI Pressure Vessel and Piping Codes and the NASA GRC Operational Safety Manual. The guidelines shall be followed when conducting a hydrostatic test of pressure vessels and piping systems.

See also Testing Schedule on Drawings.

3.3.2 Before Test Requirements

Equipment that is not to be subjected to the pressure test shall be either disconnected from the system or isolated. Valves may be used for this

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purpose provided the valve is designed for the proposed test pressure. Isolated equipment and piping not being tested shall be vented.

Water shall be used as the primary test medium. Test water shall be clean and of such quality as to minimize corrosion of the materials in the system under test. Tests with water shall not be conducted when ambient temperature is below 40-degrees F. The temperature of the water used to apply the test shall not be less than 60-degrees F. or higher than 120-degrees F. If a particular situation warrants, the COTR shall be contacted for approval to use other water temperatures or fluids as the test medium.

Vents shall be provided at all high points to purge any possible air pockets during filling the vessel or piping system. Drain connections shall be provided at low points to remove water at the conclusion of the test.

A calibrated, certified pressure gauge shall be connected to the system to be tested. The range of the gauge shall be at least 1 1/2-times the test pressure, but not greater than 2-times the test pressure. Digital pressure gauges may be used if their accuracy is as good as a calibrated dial pressure gauge.

3.3.3 Test Requirements

Before applying hydrostatic pressure, the test equipment shall be examined to see that it is tight. All low pressure filling lines and other components of the test equipment, that should not be subjected to test pressure, shall be disconnected or isolated.

The system under test shall be isolated from the hydrostatic pump by a hand valve. The calibrated pressure gauge, attached to the system, shall be observed for at least 15-minutes to ensure the leak tightness of the system. leaking will be indicated by a continuous decrease in the system pressure. Temperature changes in the system shall be monitored to correct pressure changes.

Hydrostatic test results shall be documented on the form under Article "Attachments" entitled "Hydrostatic Testing Report" in this Section. Only one vessel or system shall be documented on one report. Multiple vessels or systems require multiple reports.

The hydrostatic pressure shall be increased gradually until the system is subjected to 50% of the test pressure. At this point, the pressure shall be held for at least 10-minutes, documented on the "Hydrostatic Testing Report" under Article "Attachments" in this Section, and the system checked for leaks and other deficiencies.

After 50% of the test pressure is reached, the system pressure shall be increased in 10% increments. Pressure shall be held for at least 10-minutes at each pressure level, documented on the "Hydrostatic Testing Report" under Article "Attachments" in this Section, and visually inspected for leaks at each step. Continue the test until the full test pressure is applied.

The full test pressure shall be continuously maintained for a minimum of 30-minutes. During this time, the system shall be observed for indications of leakage. The pressure shall be documented on the "Hydrostatic Testing Report."

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The hydrostatic test pressure at any point in the piping system shall not be less than 1.5-times the design pressure (see drawings for the required test pressure), but shall not exceed the maximum allowable test pressure of any non-isolated component, such as vessels, pumps or valves.

Following the application of the full hydrostatic test pressure, the pressure shall be reduced to not less than 67% of the test pressure. A close examination of all welds, flanged, threaded, brazed, and soldered joints shall be made to pinpoint any leakage.

Upon completion of the test, the following "Hydrostatic Testing Report" shall be given to the COTR.

3.4 HYDROSTATIC TESTING REPORT

Location - Bldg. No. _____ Building
Title _____

Tested (vessel/piping)

- _____

Pipe Description:

Hydrostatic Test Parameters:

1 - Vessel or Pipe Size: _____

1 - Testing Date: _____

2 - Wall Thickness: _____

2 - Gauge Calib. Date: _____

3 - Material: _____

3 - Hydro Fluid Temp: _____ deg. F
_____ deg. C

4 - Op. Press: _____ PSIG* _____ kPa*

4 - Test Press: _____ PSIG* _____ kPa*

* As shown on drawing CF _____

**(Test Press. = 1.5 X Oper Press)

SPECIFIC	PER CENT	PRESS	PRESS	PRESSURE HELD	PRESSURE TEST
CHECK	(%) OF TEST	PSIG	kPa	FOR:	WITNESS
VERIFIED	PRESSURE				BY NASA PERSON
POINTS					
(INITIALS)					
1	50			10 min.	
2	60			10 min.	
3	70			10 min.	
4	80			10 min.	
5	90			10 min.	

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Location - Bldg. No. _____ Building
Title _____

Tested (vessel/piping)

- _____

Pipe Description:

Hydrostatic Test Parameters:

6	100			30 min.	
7	67			INSPECTION	

Remarks:

Hydrostatic Test Performed By:

Contractor: _____ Contract: NAS3- _____

Performed By: (Name/Title): _____ Date: _____

Other: (Name/Title): _____ Date: _____

NASA Witness: COTR: _____ Date: _____

Inspector: _____ Date: _____

Other: (Name/Title): _____ Date: _____

3.5 DISINFECTION

After pressure tests have been completed and before introducing the disinfection solution, piping to be disinfected shall be flushed with water, for a period of time as designated by the COTR, to remove any entrained dirt.

Water piping, including valves, fittings, and other devices, shall be disinfected with a solution of chlorine and water, and tested according to AWWA C651 (1999) Disinfecting Water Mains. Solution shall contain not less than 50 parts per million (ppm) of available chlorine. Solution shall be held for a period of not less than 8 hours, after which time the solution shall contain not less than 10 ppm of available chlorine or the piping shall be disinfected again. After successful disinfection, samples of water shall then be taken for bacteria count. The samples of water shall be sent to an independent testing lab for the count in accordance with EPA 40 CFR, Chapter 1, Section 141.14. "Maximum microbiological containment level" and the results submitted to the COTR for approval. System shall be re-sterilized until the count is approved by the COTR. Before placing the system into service, the piping shall be flushed with water for a minimum of 2 hours or until the residual chlorine is reduced to less than 1.0 ppm. All testing and flushing shall be the responsibility of the Contractor. Water for disinfection will be furnished by the Government, but disposal shall be the responsibility of the Contractor or directed to the nearest sanitary sewer and this will be determined on a case by case

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basis.

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BASIC ELECTRICAL MATERIALS AND METHODS

04/06

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA TC 13

(2005) Standard for Electrical Nonmetallic
Tubing (ENT)

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Material, Equipment, and Fixture Lists shall be submitted for the following:

Conduits, Raceway sand Fittings

SD-03 Product Data

Manufacturer's catalog data shall be submitted for the following items:

Conduits, Raceway sand Fittings

SD-08 Manufacturer's Instructions

Manufacturer's Instructions shall be submitted.

1.3 PREVENTION OF CORROSION

Metallic materials shall be protected against corrosion. Equipment enclosures shall have the standard finish by the manufacturer when used for most indoor installations. Aluminum shall not be used in contact with earth or concrete and, where connected to dissimilar metal, shall be protected by approved fittings and treatment. Ferrous metals such as, but not limited to, anchors, bolts, braces, boxes, bodies, clamps, fittings, guards, nuts, pins, rods, shims, thimbles, washers, and miscellaneous spare parts not of corrosion-resistant steel shall be hot-dip galvanized except where other equivalent protective treatment is specifically approved in writing.

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1.4 GENERAL REQUIREMENTS

Material, Equipment, and Fixture Lists shall be submitted for the following items showing manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information, and fabrication site.

Manufacturer's Instructions shall be submitted including special provisions required to install equipment components and system packages. Special notices shall detail impedances, hazards and safety precautions.

PART 2 PRODUCTS

2.1 MATERIALS

Materials and equipment to be provided shall be the standard cataloged products of manufacturers regularly engaged in the manufacture of the products.

2.1.1 Rigid Nonmetallic Conduit

Rigid nonmetallic conduit shall be in accordance with **NEMA TC 13** and shall be PVC with wall thickness not less than Schedule 40.

2.2 PULLBOXES

Pullboxes for security camera equipment shall be polymer concrete, nominal size as noted on plans. Provide additional units and stack as necessary to achieve the specified depth. Provide polymer concrete street-rated covers with the word "COMMUNICATIONS" molded in, fastened to pullboxe body with penta-head bolts. Provide a ground rod as specified elsewhere for each pullbox.

PART 3 EXECUTION

3.1 CONDUITS, RACEWAYS AND FITTINGS

Conduit runs between outlet and outlet, between fitting and fitting, or between outlet and fitting shall contain not more than the equivalent of three 90-degree bends, including those bends located immediately at the outlet or fitting.

Crushed or deformed conduit shall not be installed. Trapped conduit runs shall be avoided where possible. Care shall be taken to prevent the lodgment of foreign material in the conduit, boxes, fittings, and equipment during the course of construction. Clogged conduit shall be cleared of obstructions or shall be replaced.

3.1.1 Rigid Nonmetallic Conduit

Rigid PVC conduit must be placed in a duct bank per the Drawings.

A green insulated copper grounding conductor shall be in conduit with conductors and shall be solidly connected to ground at each end.

3.2 BOXES AND FITTINGS

Pullboxes shall be furnished and installed where indicated on the Drawings to facilitate conductor installation.

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-- End of Section --

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SECTION 31 00 00

EARTHWORK 07/06

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO T 180 (2001; R 2004) Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and an 457-mm (18-in) Drop

AASHTO T 224 (2001; R 2004) Correction for Coarse Particles in the Soil Compaction Test

ASTM INTERNATIONAL (ASTM)

ASTM C 136 (2006) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates

ASTM D 1140 (2000; R 2006) Amount of Material in Soils Finer than the No. 200 (75-micrometer) Sieve

ASTM D 1556 (2000) Density and Unit Weight of Soil in Place by the Sand-Cone Method

ASTM D 1557 (2002e1) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³) (2700 kN-m/m³)

ASTM D 2434 (1968; R 2006) Permeability of Granular Soils (Constant Head)

ASTM D 2487 (2006) Soils for Engineering Purposes (Unified Soil Classification System)

ASTM D 422 (1963; R 2002e1) Particle-Size Analysis of Soils

ASTM D 4318 (2005) Liquid Limit, Plastic Limit, and Plasticity Index of Soils

ASTM D 6938 (2007a) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

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U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 600/4-79/020

(1983) Methods for Chemical Analysis of Water and Wastes

EPA SW-846.3-3

(1999, Third Edition, Update III-A) Test Methods for Evaluating Solid Waste: Physical/Chemical Methods

1.2 DEFINITIONS

1.2.1 Satisfactory Materials

Satisfactory materials comprise any materials classified by [ASTM D 2487](#) as GW, GP, GM, GP-GM, GW-GM, GC, GP-GC, GM-GC, SW, SP, SM, SW-SM, SC, SW-SC, SP-SM, SP-SC, CL. Satisfactory materials for grading comprise stones less than [8 inches](#), except for fill material for pavements and railroads which comprise stones less than [3 inches](#) in any dimension.

1.2.2 Unsatisfactory Materials

Materials which do not comply with the requirements for satisfactory materials are unsatisfactory. Unsatisfactory materials also include man-made fills; trash; refuse; backfills from previous construction; and material classified as satisfactory which contains root and other organic matter or frozen material. Notify the Contracting Officer when encountering any contaminated materials.

1.2.3 Cohesionless and Cohesive Materials

Cohesionless materials include materials classified in [ASTM D 2487](#) as GW, GP, SW, and SP. Cohesive materials include materials classified as GC, SC, ML, CL, MH, and CH. Materials classified as GM and SM will be identified as cohesionless only when the fines are nonplastic. Perform testing, required for classifying materials, in accordance with [ASTM D 4318](#), [ASTM C 136](#), [ASTM D 422](#), and [ASTM D 1140](#).

1.2.4 Degree of Compaction

Degree of compaction required, except as noted in the second sentence, is expressed as a percentage of the maximum density obtained by the test procedure presented in [ASTM D 1557](#) abbreviated as a percent of laboratory maximum density. Since [ASTM D 1557](#) applies only to soils that have 30 percent or less by weight of their particles retained on the [3/4 inch](#) sieve, express the degree of compaction for material having more than 30 percent by weight of their particles retained on the [3/4 inch](#) sieve as a percentage of the maximum density in accordance with [AASHTO T 180](#) and corrected with [AASHTO T 224](#). To maintain the same percentage of coarse material, use the "remove and replace" procedure as described in NOTE 8 of Paragraph 7.2 in [AASHTO T 180](#).

1.2.5 Topsoil

Material suitable for topsoils obtained from excavations is defined as: Natural, friable soil representative of productive, well-drained soils in the area, free of subsoil, stumps, rocks larger than [one inch](#) diameter, brush, weeds, toxic substances, and other material detrimental to plant growth. Amend topsoil pH range to obtain a pH of 5.5 to 7.

1.2.6 Hard/Unyielding Materials

Hard/Unyielding materials comprise weathered rock, dense consolidated deposits, or conglomerate materials which are not included in the definition of "rock". These materials usually require the use of heavy excavation equipment, ripper teeth, or jack hammers for removal.

1.2.7 Rock

Solid homogeneous interlocking crystalline material with firmly cemented, laminated, or foliated masses or conglomerate deposits, neither of which can be removed without systematic drilling and blasting, drilling and the use of expansion jacks or feather wedges, or the use of backhoe-mounted pneumatic hole punchers or rock breakers; also large boulders, buried masonry, or concrete other than pavement exceeding 1/2 cubic yard in volume. Removal of hard material will not be considered rock excavation because of intermittent drilling and blasting that is performed merely to increase production.

1.2.8 Unstable Material

Unstable material are too wet to properly support the utility pipe, conduit, or appurtenant structure.

1.2.9 Select Granular Material

1.2.9.1 General Requirements

Select granular material consist of materials classified as GW, GP, SW, or SP by ASTM D 2487 where indicated. The liquid limit of such material must not exceed 35 percent when tested in accordance with ASTM D 4318. The plasticity index must not be greater than 12 percent when tested in accordance with ASTM D 4318, and not more than 35 percent by weight may be finer than No. 200 sieve when tested in accordance with ASTM D 1140. Provide a minimum coefficient of permeability of 0.002 feet per minute when tested in accordance with ASTM D 2434.

1.2.10 Initial Backfill Material

Initial backfill consists of select granular material or satisfactory materials free from rocks 3 mm inches or larger in any dimension or free from rocks of such size as recommended by the pipe manufacturer, whichever is smaller. When the pipe is coated or wrapped for corrosion protection, free the initial backfill material of stones larger than 2 mm inches in any dimension or as recommended by the pipe manufacturer, whichever is smaller.

1.2.11 Expansive Soils

Expansive soils are defined as soils that have a plasticity index equal to or greater than 22 when tested in accordance with ASTM D 4318.

1.2.12 Nonfrost Susceptible (NFS) Material

Nonfrost susceptible material are a uniformly graded washed sand with a maximum particle size of 2 inch and less than 5 percent passing the No. 200 size sieve, and with not more than 3 percent by weight finer than 0.02 mm grain size.

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1.3 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Dewatering Plan
Shoring

SD-06 Test Reports

Testing
Borrow Site Testing

Within 24 hours of conclusion of physical tests, 3 copies of test results, including calibration curves and results of calibration tests. Results of testing at the borrow site.

1.4 SUBSURFACE DATA

Subsurface soil boring logs are appended herein. The subsoil investigation report may be examined by request from the Contracting Officer. These data represent the best subsurface information available; however, variations may exist in the subsurface between boring locations.

1.5 CLASSIFICATION OF EXCAVATION

No consideration will be given to the nature of the materials, and all excavation will be designated as unclassified excavation.

1.6 CRITERIA FOR BIDDING

Base bids on the following criteria:

- a. Surface elevations are as indicated.
- b. Pipes or other artificial obstructions, except those indicated, will not be encountered.
- c. Ground water elevations indicated by the boring log were those existing at the time subsurface investigations were made and do not necessarily represent ground water elevation at the time of construction.

Material character is indicated by the boring logs.

1.7 DEWATERING WORK PLAN

Submit procedures for accomplishing dewatering work.

PART 2 PRODUCTS

2.1 REQUIREMENTS FOR OFFSITE SOILS

Test offsite soils brought in for use as backfill for Total Petroleum Hydrocarbons (TPH), Benzene, Toluene, Ethyl Benzene, and Xylene (BTEX) and

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full Toxicity Characteristic Leaching Procedure (TCLP) including ignitability, corrosivity and reactivity. Backfill shall contain a maximum of 100 parts per million (ppm) of total petroleum hydrocarbons (TPH) and a maximum of 10 ppm of the sum of Benzene, Toluene, Ethyl Benzene, and Xylene (BTEX) and shall pass the TCPL test. Determine TPH concentrations by using EPA 600/4-79/020 Method 418.1. Determine BTEX concentrations by using EPA SW-846.3-3 Method 5030/8020. Perform TCLP in accordance with EPA SW-846.3-3 Method 1311. Provide Borrow Site Testing for TPH, BTEX and TCLP from a composite sample of material from the borrow site, with at least one test from each borrow site. Do not bring material onsite until tests have been approved by the Contracting Officer.

PART 3 EXECUTION

3.1 STRIPPING OF TOPSOIL

Strip topsoil to a depth as indicated by soil borings. Spread topsoil on areas already graded and prepared for topsoil, or transported and deposited in stockpiles convenient to areas that are to receive application of the topsoil later. Stockpile site to be approved by Contracting Officer before use. Keep topsoil separate from other excavated materials, brush, litter, objectionable weeds, roots, stones larger than 2 inch in diameter, and other materials that would interfere with planting and maintenance operations.

3.2 GENERAL EXCAVATION

Perform excavation of every type of material encountered within the limits of the project to the lines, grades, and elevations indicated and as specified. Perform the grading in accordance with the typical sections shown and the tolerances specified in paragraph FINISHING. Transport satisfactory excavated materials and place in fill or embankment within the limits of the work. Excavate unsatisfactory materials encountered within the limits of the work below grade and replace with satisfactory materials as directed. Include such excavated material and the satisfactory material ordered as replacement in excavation. Dispose surplus satisfactory excavated material not required for fill or embankment in areas approved for surplus material storage or designated waste areas. Dispose unsatisfactory excavated material in designated waste or spoil areas. During construction, perform excavation and fill in a manner and sequence that will provide proper drainage at all times. Excavate material required for fill or embankment in excess of that produced by excavation within the grading limits from the borrow areas indicated or from other approved areas selected by the Contractor as specified.

3.2.1 Ditches, Gutters, and Channel Changes

Finish excavation of ditches, gutters, and channel changes by cutting accurately to the cross sections, grades, and elevations shown on Drawings. Do not excavate ditches and gutters below grades shown. Backfill the excessive open ditch or gutter excavation with satisfactory, thoroughly compacted, material or with suitable stone or cobble to grades shown. Dispose excavated material as shown or as directed, except in no case allow material be deposited a maximum 4 feet from edge of a ditch. Maintain excavations free from detrimental quantities of leaves, brush, sticks, trash, and other debris until final acceptance of the work.

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3.2.2 Drainage Structures

Make excavations to the lines, grades, and elevations shown, or as directed. Provide trenches and foundation pits of sufficient size to permit the placement and removal of forms for the full length and width of structure footings and foundations as shown. Clean rock or other hard foundation material of loose debris and cut to a firm, level, stepped, or serrated surface. Remove loose disintegrated rock and thin strata. Do not disturb the bottom of the excavation when concrete or masonry is to be placed in an excavated area. Do not excavate to the final grade level until just before the concrete or masonry is to be placed. Where pile foundations are to be used, stop the excavation of each pit at an elevation **1 foot** above the base of the footing, as specified, before piles are driven. After the pile driving has been completed, remove loose and displaced material and complete excavation, leaving a smooth, solid, undisturbed surface to receive the concrete or masonry.

3.2.3 Drainage

Provide for the collection and disposal of surface and subsurface water encountered during construction. Completely drain construction site during periods of construction to keep soil materials sufficiently dry. Construct storm drainage features (ponds/basins) at the earliest stages of site development, and throughout construction grade the construction area to provide positive surface water runoff away from the construction activity or provide temporary ditches, swales, and other drainage features and equipment as required to maintain dry soils. When unsuitable working platforms for equipment operation and unsuitable soil support for subsequent construction features develop, remove unsuitable material and provide new soil material as specified herein. It is the responsibility of the Contractor to assess the soil and ground water conditions presented by the plans and specifications and to employ necessary measures to permit construction to proceed.

3.2.4 Dewatering

Control groundwater flowing toward or into excavations to prevent sloughing of excavation slopes and walls, boils, uplift and heave in the excavation and to eliminate interference with orderly progress of construction. Do not permit French drains, sumps, ditches or trenches within **3 feet** of the foundation of any structure, except with specific written approval, and after specific contractual provisions for restoration of the foundation area have been made. Take control measures by the time the excavation reaches the water level in order to maintain the integrity of the in situ material. While the excavation is open, maintain the water level continuously, below the working level. Operate dewatering system continuously until construction work below existing water levels is complete.

3.2.5 Underground Utilities

The Contractor is responsible for movement of construction machinery and equipment over pipes and utilities during construction. For work immediately adjacent to or for excavations exposing a utility or other buried obstruction, excavate by hand. Start hand excavation on each side of the indicated obstruction and continue until the obstruction is uncovered or until clearance for the new grade is assured. Support uncovered lines or other existing work affected by the contract excavation until approval for backfill is granted by the Contracting Officer. Report

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damage to utility lines or subsurface construction immediately to the Contracting Officer.

3.3 SELECTION OF BORROW MATERIAL

Select borrow material to meet the requirements and conditions of the particular fill or embankment for which it is to be used. Obtain borrow material from the stockpile areas within the limits of the project site, or from approved private sources. Unless otherwise provided in the contract, the Contractor is responsible for obtaining the right to procure material, pay royalties and other charges involved, and bear the expense of developing the sources, including rights-of-way for hauling from the owners.

3.4 SHORING

3.4.1 General Requirements

Submit a Shoring and Sheet piling plan for approval 15 days prior to starting work. Submit drawings and calculations, certified by a registered professional engineer, describing the methods for shoring and sheet piling of excavations. Finish shoring, including sheet piling, and install as necessary to protect workmen, banks, adjacent paving, structures, and utilities. Remove shoring, bracing, and sheet piling as excavations are backfilled, in a manner to prevent caving.

3.5 Geotechnical Engineer

The Contractor is required to hire a Professional Geotechnical Engineer to provide inspection of excavations and soil/groundwater conditions throughout construction. The Geotechnical Engineer is responsible for performing pre-construction and periodic site visits throughout construction to assess site conditions. The Geotechnical Engineer is responsible for updating the excavation, sheet piling and dewatering plans as construction progresses to reflect changing conditions and submit an updated plan if necessary. The Geotechnical Engineer is responsible for performing all compaction testing, soils gradation and testing and rendering field determinations about completeness of work as described in paragraph TESTING. Submit a monthly written report, informing the Contractor and Contracting Officer of the status of the plan and an accounting of the Contractor's adherence to the plan addressing any present or potential problems. The Contracting Officer is responsible for arranging meetings with the Geotechnical Engineer at any time throughout the contract duration.

3.6 GRADING AREAS

Where indicated, divide work into grading areas within which satisfactory excavated material will be placed in embankments, fills, and required backfills. Do not haul satisfactory material excavated in one grading area to another grading area except when so directed in writing. Place and grade stockpiles of satisfactory material as specified. Keep stockpiles in a neat and well drained condition, giving due consideration to drainage at all times. Clear, grub, and seal by rubber-tired equipment, the ground surface at stockpile locations; separately stockpile excavated satisfactory and unsatisfactory materials. Protect stockpiles of satisfactory materials from contamination which may destroy the quality and fitness of the stockpiled material. If the Contractor fails to protect the stockpiles, and any material becomes unsatisfactory, remove and replace such material

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with satisfactory material from approved sources.

3.7 GROUND SURFACE PREPARATION

3.7.1 General Requirements

Remove and replace unsatisfactory material with satisfactory materials, as directed by the Contracting Officer, in surfaces to receive fill or in excavated areas. Scarify the surface to a depth of 6 inch before the fill is started. Plow, step, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so that the fill material will bond with the existing material. When subgrades are less than the specified density, break up the ground surface to a minimum depth of 6 inch, pulverizing, and compacting to the specified density. When the subgrade is part fill and part excavation or natural ground, scarify the excavated or natural ground portion to a depth of 12 inch and compact it as specified for the adjacent fill.

3.7.2 Frozen Material

Do not place material on surfaces that are muddy, frozen, or contain frost. Finish compaction by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, or other approved equipment well suited to the soil being compacted. Moisten material as necessary to plus or minus 2 percent of optimum moisture.

3.8 UTILIZATION OF EXCAVATED MATERIALS

Dispose unsatisfactory materials removing from excavations off site into properly designated waste disposal or spoil areas. Use satisfactory material removed from excavations, insofar as practicable, in the construction of fills, embankments, subgrades, shoulders, bedding (as backfill), and for similar purposes. Do not waste any satisfactory excavated material without specific written authorization. Dispose of satisfactory material, authorized to be wasted, in designated areas approved for surplus material storage or designated waste areas as directed. Clear and grub newly designated waste areas on Government-controlled land before disposal of waste material thereon. Stockpile and use coarse rock from excavations for constructing slopes or embankments adjacent to streams, or sides and bottoms of channels and for protecting against erosion. Do not dispose excavated material to obstruct the flow of any stream, endanger a partly finished structure, impair the efficiency or appearance of any structure, or be detrimental to the completed work in any way.

3.9 BACKFILLING AND COMPACTION

Place backfill adjacent to any and all types of structures, and compact in conformance with the applicable portions of paragraph COMPACTION. Prepare ground surface on which backfill is to be placed as specified in paragraph GROUND SURFACE PREPARATION. Provide compaction requirements for backfill materials in conformance with the applicable portions of paragraphs GROUND SURFACE PREPARATION. Finish compaction by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment.

3.9.1 Backfill for Appurtenances

After the manhole, catchbasin, inlet, or similar structure has been

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constructed, place backfill in such a manner that the structure is not be damaged by the shock of falling earth. Deposit the backfill material, compact it as specified for final backfill, and bring up the backfill evenly on all sides of the structure to prevent eccentric loading and excessive stress.

3.10 SUBGRADE PREPARATION

3.10.1 Proof Rolling

Finish proof rolling on an exposed subgrade free of surface water (wet conditions resulting from rainfall) which would promote degradation of an otherwise acceptable subgrade. After stripping, proof roll the existing subgrade with six passes of a dump truck loaded with 4 cubic yards of soil or 15 ton pneumatic-tired roller. Operate the roller or truck in a systematic manner to ensure the number of passes over all areas, and at speeds between 2-1/2 to 3-1/2 mph. When proof rolling, provide one-half of the passes made with the roller in a direction perpendicular to the other passes. Notify the Contracting Officer a minimum of 3 days prior to proof rolling. Perform proof rolling in the presence of the Contracting Officer. Undercut rutting or pumping of material as directed by the Contracting Officer and replace with fill and backfill material.

3.10.2 Construction

Shape subgrade to line, grade, and cross section, and compact as specified. Include plowing, disking, and any moistening or aerating required to obtain specified compaction for this operation. Remove soft or otherwise unsatisfactory material and replace with satisfactory excavated material or other approved material as directed. Excavate rock encountered in the cut section to a depth of 6 inch below finished grade for the subgrade. Bring up low areas resulting from removal of unsatisfactory material or excavation of rock to required grade with satisfactory materials, and shape the entire subgrade to line, grade, and cross section and compact as specified. After rolling, do not show deviations for the surface of the subgrade for roadways greater than 1/2 inch when tested with a 12-foot straightedge applied both parallel and at right angles to the centerline of the area. Do not vary the elevation of the finish subgrade more than 0.05 foot from the established grade and cross section.

3.10.3 Compaction

Finish compaction by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment. Except for lawns and grass areas compact each layer of fill or backfill to at least 100 percent of laboratory maximum density for non-cohesive soil and 102 percent of laboratory maximum density for cohesive soils as determined by ASTM D 698 Standard Proctor test.

3.10.3.1 Subgrade for Lawns and Grass Areas

Compact fill or backfill for lawns and grass areas to at least 90 percentage laboratory maximum density.

3.11 FINISHING

Finish the surface of excavations, embankments, and subgrades to a smooth and compact surface in accordance with the lines, grades, and cross sections or elevations shown. Provide the degree of finish for graded

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areas within 0.1 foot of the grades and elevations indicated except that the degree of finish for subgrades specified in paragraph SUBGRADE PREPARATION. Finish gutters and ditches in a manner that will result in effective drainage. Finish the surface of areas to be turfed from settlement or washing to a smoothness suitable for the application of turfing materials. Repair graded, topsoiled, or backfilled areas prior to acceptance of the work, and re-established grades to the required elevations and slopes.

3.11.1 Subgrade and Embankments

During construction, keep embankments and excavations shaped and drained. Maintain ditches and drains along subgrade to drain effectively at all times. Do not disturb the finished subgrade by traffic or other operation. The Contractor is responsible for protecting and maintaining the finished subgrade in a satisfactory condition until ballast, subbase, base, or pavement is placed. Do not permit the storage or stockpiling of materials on the finished subgrade. Do not lay subbase, base course, ballast, or pavement until the subgrade has been checked and approved, and in no case place subbase, base, surfacing, pavement, or ballast on a muddy, spongy, or frozen subgrade.

3.11.2 Grading Around Structures

Construct areas within 5 feet outside of each building and structure line true-to-grade, shape to drain, and maintain free of trash and debris until final inspection has been completed and the work has been accepted.

3.12 TESTING

Perform testing by a commercial testing laboratory approved by the Contracting Officer. Determine field in-place density in accordance with ASTM D 6938. When ASTM D 6938 is used, check the calibration curves and adjust using only the sand cone method as described in ASTM D 1556. ASTM D 6938 results in a wet unit weight of soil in determining the moisture content of the soil when using this method. Check the calibration curves furnished with the moisture gauges along with density calibration checks as described in ASTM D 6938; check the calibration of both the density and moisture gauges at the beginning of a job on each different type of material encountered. When test results indicate, as determined by the Contracting Officer, that compaction is not as specified, remove the material, replace and recompact to meet specification requirements. Perform tests on recompacted areas to determine conformance with specification requirements. Appoint a registered professional engineer to certify inspections and test results. These certifications shall state that the tests and observations were performed by or under the direct supervision of the engineer and that the results are representative of the materials or conditions being certified by the tests. The following number of tests, if performed at the appropriate time, will be the minimum acceptable for each type operation.

3.12.1 Fill and Backfill Material Gradation

One test per 500 cubic yards or fraction thereof, stockpiled or in-place source material. Determine gradation of fill and backfill material in accordance with appropriate ASTM guidelines.

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3.12.2 In-Place Densities

- a. One test per 1500 square feet, or fraction thereof, of each lift of fill or backfill areas compacted by other than hand-operated machines.
- b. One test per 500 square feet, or fraction thereof, of each lift of fill or backfill areas compacted by hand-operated machines.
- c. One test per 1000 square feet, or fraction thereof, of each lift of fill or backfill for roads.

3.12.3 Check Tests on In-Place Densities

If ASTM D 6938 is used, check in-place densities by ASTM D 1556 as follows:

- a. One check test per lift for each 20 of the above tests.

3.12.4 Moisture Contents

In the stockpile, excavation, or borrow areas, perform a minimum of two tests per day per type of material or source of material being placed during stable weather conditions. During unstable weather, perform tests as dictated by local conditions and approved by the Contracting Officer.

3.12.5 Optimum Moisture and Laboratory Maximum Density

Perform tests for each type material or source of material including borrow material to determine the optimum moisture and laboratory maximum density values. One representative test per 500 cubic yards of fill and backfill, or when any change in material occurs which may affect the optimum moisture content or laboratory maximum density.

3.12.6 Tolerance Tests for Subgrades

Perform continuous checks on the degree of finish specified in paragraph SUBGRADE PREPARATION during construction of the subgrades.

3.13 DISPOSITION OF SURPLUS MATERIAL

Provide surplus material or other soil material not required or suitable for filling or backfilling, and brush, refuse, stumps, roots, and timber as removed from Government property.

-- End of Section --

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SECTION 31 05 19

GEOTEXTILE 04/06

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D 4354	(1999; R 2004) Sampling of Geosynthetics for Testing
ASTM D 4355	(2007) Deterioration of Geotextiles from Exposure to Light, Moisture and Heat in a Xenon-Arc Type Apparatus
ASTM D 4491	(1999a; R 2004e1) Water Permeability of Geotextiles by Permittivity
ASTM D 4533	(2004) Trapezoid Tearing Strength of Geotextiles
ASTM D 4632	(1991; R 2003) Grab Breaking Load and Elongation of Geotextiles
ASTM D 4751	(2004) Determining Apparent Opening Size of a Geotextile
ASTM D 4759	(2002) Determining the Specification Conformance of Geosynthetics
ASTM D 4833	(2000e1) Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
ASTM D 4873	(2002) Identification, Storage, and Handling of Geosynthetic Rolls and Samples

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

A minimum of 14 days prior to scheduled use, proposed product data sheets showing the physical properties of the product.

SD-07 Certificates

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Geotextile

A minimum of 14 days prior to scheduled use, manufacturer's certificate of compliance stating that the geotextile meets the requirements of this section. The certificate of compliance shall be attested to by a person having legal authority to bind the geotextile manufacturer.

1.3 DELIVERY, STORAGE AND HANDLING

Delivery, storage, and handling of geotextile shall be in accordance with ASTM D 4873.

1.3.1 Delivery

Rolls shall be packaged in an opaque, waterproof, protective plastic wrapping. The plastic wrapping shall not be removed until deployment. Geotextile or plastic wrapping damaged during storage or handling shall be repaired or replaced, as directed. Each roll shall be labeled with the manufacturer's name, geotextile type, roll number, roll dimensions (length, width, gross weight), and date manufactured.

1.3.2 Storage

Rolls of geotextile shall be protected from construction equipment, chemicals, sparks and flames, temperatures in excess of 160 degrees F, or any other environmental condition that may damage the physical properties of the geotextile. To protect geotextile from becoming saturated, rolls shall either be elevated off the ground or placed on a sacrificial sheet of plastic in an area where water will not accumulate.

1.3.3 Handling

Geotextile rolls shall be handled and unloaded with load carrying straps, a fork lift with a stinger bar, or an axial bar assembly. Rolls shall not be dragged along the ground, lifted by one end, or dropped to the ground.

PART 2 PRODUCTS

2.1 RAW MATERIALS

2.1.1 Geotextile

Geotextile shall be a nonwoven pervious sheet of polymeric material and shall consist of long-chain synthetic polymers composed of at least 95 percent by weight polyolefins, polyesters, or polyamides. The use of woven slit film geotextiles (i.e. geotextiles made from yarns of a flat, tape-like character) will not be allowed. Stabilizers and/or inhibitors shall be added to the base polymer, as needed, to make the filaments resistant to deterioration by ultraviolet light, oxidation, and heat exposure. Regrind material, which consists of edge trimmings and other scraps that have never reached the consumer, may be used to produce the geotextile. Post-consumer recycled material may also be used. Geotextile shall be formed into a network such that the filaments or yarns retain dimensional stability relative to each other, including the edges. Geotextiles shall meet the requirements specified in Table 1. Where applicable, Table 1 property values represent minimum average roll values (MARV) in the weakest principal direction. Values for AOS represent maximum average roll values.

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TABLE 1
MINIMUM PHYSICAL REQUIREMENTS FOR DRAINAGE GEOTEXTILE

PROPERTY	UNITS	ACCEPTABLE VALUES	TEST METHOD
Tensile STRENGTH	LBS	200	ASTM D 4632
PUNCTURE	LBS	80	ASTM D 4833
TEAR	LBS	50	ASTM D 4533
APPARENT OPENING SIZE	MM	≤0.6	ASTM D 4751
PERMITTIVITY	SEC -1	0.2	ASTM D 4491
ULTRAVIOLET DEGRADATION	PERCENT	50 AT 500 HRS	ASTM D 4355

2.2 MANUFACTURING QUALITY CONTROL SAMPLING AND TESTING

The Manufacturer shall be responsible for establishing and maintaining a quality control program to assure compliance with the requirements of the specification. Documentation describing the quality control program shall be made available upon request. Manufacturing quality control sampling and testing shall be performed in accordance with the manufacturer's approved quality control manual. As a minimum, geotextiles shall be randomly sampled for testing in accordance with ASTM D 4354, Procedure A. Acceptance of geotextile shall be in accordance with ASTM D 4759. Tests not meeting the specified requirements shall result in the rejection of applicable rolls.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Subgrade Preparation

The surface underlying the geotextile shall be smooth and free of ruts or protrusions which could damage the geotextile. Subgrade materials and compaction requirements shall be in accordance with Section 31 00 00.

3.1.2 Placement

The Contractor shall notify the Contracting Officer a minimum of 24 hours prior to installation of geotextile. Geotextile rolls which are damaged or contain imperfections shall be repaired or replaced as directed. The geotextile shall be laid flat and smooth so that it is in direct contact with the subgrade. The geotextile shall also be free of tensile stresses, folds, and wrinkles.

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3.2 SEAMS

3.2.1 Overlap Seams

Geotextile panels shall be continuously overlapped a minimum of 12 inches at all longitudinal and transverse joints. Where seams must be oriented across the slope, the upper panel shall be lapped over the lower panel.

3.3 PROTECTION

The geotextile shall be protected during installation from clogging, tears, and other damage. Damaged geotextile shall be repaired or replaced as directed. Adequate ballast (e.g. sand bags) shall be used to prevent uplift by wind. The geotextile shall not be left uncovered for more than 3 days after installation.

3.4 REPAIRS

Torn or damaged geotextile shall be repaired. Clogged areas of geotextile shall be removed. Repairs shall be performed by placing a patch of the same type of geotextile over the damaged area. The patch shall extend a minimum of 12 inches beyond the edge of the damaged area. Patches shall be continuously fastened using approved methods. The machine direction of the patch shall be aligned with the machine direction of the geotextile being repaired. Geotextile rolls which cannot be repaired shall be removed and replaced. Repairs shall be performed at no additional cost to the Government

3.5 COVERING

Geotextile shall not be covered prior to inspection and approval by the Contracting Officer. Cover soil shall be placed in a manner that prevents soil from entering the geotextile overlap zone, prevents tensile stress from being mobilized in the geotextile, and prevents wrinkles from folding over onto themselves. Cover soil shall not be dropped onto the geotextile from a height greater than 3 feet. No equipment shall be operated directly on top of the geotextile without approval of the Contracting Officer. Equipment with ground pressures less than 7 psi shall be used to place the first lift over the geotextile. A minimum of 12 inches of soil shall be maintained between full-scale construction equipment and the geotextile. Cover soil material type, compaction, and testing requirements are described in Section 31 00 00. Equipment placing cover soil shall not stop abruptly, make sharp turns, spin their wheels, or travel at speeds exceeding 5 mph.

-- End of Section --

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SECTION 31 05 20

GEOSYNTHETIC DRAINAGE LAYER 04/06

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D 1505	(2003) Density of Plastics by the Density-Gradient Technique
ASTM D 1603	(2006) Carbon Black Content in Olefin Plastics
ASTM D 4218	(1996; R 2001) Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique
ASTM D 4355	(2007) Deterioration of Geotextiles from Exposure to Light, Moisture and Heat in a Xenon-Arc Type Apparatus
ASTM D 4491	(1999a; R 2004e1) Water Permeability of Geotextiles by Permittivity
ASTM D 4533	(2004) Trapezoid Tearing Strength of Geotextiles
ASTM D 4632	(1991; R 2003) Grab Breaking Load and Elongation of Geotextiles
ASTM D 4716	(2004) Determining the (In-Plane) Flow Rate Per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head
ASTM D 4751	(2004) Determining Apparent Opening Size of a Geotextile
ASTM D 4833	(2000e1) Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
ASTM D 5035	(2006) Breaking Force and Elongation of Textile Fabrics (Strip Method)
ASTM D 5199	(2001; R 2006) Measuring Nominal Thickness of Geosynthetics
ASTM D 5261	(1992; R 2003) Measuring Mass Per Unit

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Area of Geotextiles

GEOSYNTHETIC INSTITUTE (GSI)

GSI GRI GC7

(1997) Determination of Adhesion and Bond
Strength of Geocomposites

1.2 MEASUREMENT AND PAYMENT

Measurement shall be made of the total surface area in square feet covered by geosynthetic drainage layer. Final quantities shall be based on as-built conditions. Allowance will be made for geosynthetic drainage layer in anchor and/or drainage trenches but no allowance will be made for waste, overlap, or materials used for the convenience of the Contractor. Geosynthetic drainage layer accepted by the Contracting Officer will be paid for at the respective contract unit price in the bidding schedule.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Sampling and Testing

Manufacturer's quality control manual.

Penetrations

Penetration details.

Construction Quality Control Laboratory

Qualifications of Construction Quality Control laboratory.

SD-04 Samples

Geosynthetic Drainage Layer Seams and Overlaps

One properly identified 24 by 24 inch minimum size geosynthetic drainage layer sample. The fasteners proposed for use and the method of seaming and overlapping shall also be submitted.

SD-06 Test Reports

Sampling and Testing

Construction quality control test results.

Geosynthetic Drainage Layer

Manufacturer's quality control test results.

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1.4 CONSTRUCTION QUALITY CONTROL LABORATORY

The construction quality control (QC) laboratory shall have provided QC and/or quality assurance (QA) testing of geosynthetic drainage layers for at least five completed projects having a total minimum area of 2 million square feet. The QC laboratory shall carry current accreditation via the Geosynthetic Accreditation Institute's Laboratory Accreditation Program (GAI-LAP) for the tests the QC laboratory will be required to perform.

1.5 DELIVERY, STORAGE AND HANDLING

The QC inspector shall be present during delivery and unloading of the geosynthetic drainage layer. The drainage layer material shall not be damaged during shipping, storage, or handling. Any drainage layer material found to be damaged shall be repaired or replaced. Material shall be delivered only after the required submittals have been approved. Each roll shall be labelled with the manufacturer's name, product identification, lot number, roll number, and roll dimensions. Rolls that have attached geotextiles shall be individually wrapped in plastic. The rolls shall be stored in a level and dry area.

PART 2 PRODUCTS

2.1 GEOSYNTHETIC DRAINAGE LAYER

The polymer used to manufacture the geonet component of the geosynthetic drainage layer shall be polyethylene which is clean and free of any foreign contaminants. Regrind material which consists of edge trimmings and other scraps may be used to manufacture the geonet; however, post-consumer recycled materials shall not be used. The geosynthetic drainage layer shall conform to the property requirements listed in Table 1. Component criteria for the geonet alone and geotextile alone are also listed in Table 1. The geonet shall be covered on both sides with nonwoven geotextile. Geocomposite shall be created by heat bonding geotextile to the geonet. The geotextile shall not be bonded to the drainage net within 6 inches of the edges of the rolls. Where applicable, Table 1 property values represent minimum average roll values (MARV). The value for AOS represents the maximum average roll value (MaxARV).

TABLE 1 - GEOSYNTHETIC DRAINAGE LAYER PROPERTIES

PROPERTY	TEST METHOD	TEST VALUE	MINIMUM MQC TESTING FREQUENCY
GEONET			
Thickness, minimum avg, Note 1	ASTM D 5199	200 mil	100,000 SF
Polymer Density, minimum avg	ASTM D 1505	0.940 g/cc	100,000 SF
Carbon Black Content	ASTM D 1603 ASTM D 4218	1-3 percent	100,000 SF
Tensile Strength, minimum avg, Note 2	ASTM D 5035	45 lbs/in	100,000 SF
GEOTEXTILE			

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TABLE 1 - GEOSYNTHETIC DRAINAGE LAYER PROPERTIES

PROPERTY	TEST METHOD	TEST VALUE	MINIMUM MQC TESTING FREQUENCY
Mass/Unit Area, MARV	ASTM D 5261	6.0 oz/SY	100,000 SF
Grab Strength, MARV	ASTM D 4632	157 lbs	100,000 SF
Grab Elongation, MARV	ASTM D 4632	50 percent	100,000 SF
Tear Strength, MARV	ASTM D 4533	55 lbs	100,000 SF
Puncture Strength, MARV	ASTM D 4833	55 lbs	100,000 SF
Permittivity, MARV	ASTM D 4491	.2/sec	500,000 SF
AOS(O95), MaxARV	ASTM D 4751	.25 mm	500,000 SF
UV Stability, percent retained (500 hrs)	ASTM D 4355	50 percent	Note 3
GEOCOMPOSITE			
Transmissivity, min, including attached geotextiles Note 4	ASTM D 4716	.1 gal/ min-foot	200,000 SF
Geonet/Geotextile Adhesion, minimum avg, Note 5	GSI GRI GC7	0.5 lbs/inch	100,000 SF

Note 1: The diameter of the presser foot shall be 2.22 inches and the pressure shall be 2.9 psi. For other thickness options, see manufacturer's literature.

Note 2: This is the average peak value for five equally spaced machine direction tests across the roll width.

Note 3: Manufacturer's historical data.

Note 4: Manufacturing quality control transmissivity tests shall be measured using a gradient of 0.1 under a normal pressure of 1.45 psi. A minimum seating period of 15 minutes shall be used. The test shall be performed between rigid end platens.

Note 5: Average of five tests across the roll width. Discounting the outer 305 mm of each side of the roll, samples shall be collected at the 10, 30, 50, 70, and 90 percent positions across the roll width. Both sides shall be tested for double sided geocomposites.

2.2 SAMPLING AND TESTING

2.2.1 Manufacturing Quality Control Testing

Manufacturing quality control test methods and frequencies shall be in accordance with Table 1 unless otherwise approved.

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2.2.2 Construction Quality Control Testing

A minimum of one construction quality control transmissivity test shall be performed in accordance with the requirements of this paragraph. Transmissivity shall be measured using a gradient of 1.1 under a normal pressure of 10 [psf](#). Geotextile shall be attached to the geonet in the same configuration as will be used in the field. A minimum seating period of 100 hours shall be used. The construction quality control test results must achieve a minimum transmissivity of .1.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Surface Preparation

Prior to placement of the geosynthetic drainage layer, the subgrade shall be smooth and free of all materials which could damage the drainage layer.

3.1.2 Placement

The geosynthetic drainage layer shall not be damaged during placement. The drainage layer shall be unrolled in the direction of maximum slope, keeping the net flat against the subgrade to minimize wrinkles and folds. The drainage layer shall not be dragged across textured geomembrane if a geotextile is attached to the surface facing the geomembrane. Adequate ballast (e.g. sandbags) shall be placed to prevent uplift by wind prior to covering.

3.1.3 [Seams and Overlaps](#)

3.1.3.1 Geonet Side Seams

Geonet side seams shall be overlapped a minimum of [4 inches](#). Side seam fastener spacing shall be a maximum of [5 feet](#). In anchor trenches, fastener spacing shall be a maximum of [1 foot](#).

3.1.3.2 Geonet End Seams

Geonet end seams shall be overlapped a minimum of [1 foot](#). End seam fastener spacing shall be a maximum of [1 foot](#). The overlaps shall be in the direction of flow.

3.1.3.3 Geonet Fasteners

Geonet rolls shall be tied together with plastic fasteners. The fasteners shall be a contrasting color from the geonet and attached geotextiles. Metallic fasteners will not be allowed.

3.1.3.4 Geotextile Seams

The geotextile component of the geocomposite shall be overlapped in the direction of flow sewn using approved methods.

3.1.3.5 Geotextile Cap Strips

Geotextile cap strips shall be placed over any exposed edges of geocomposite. Cap strips shall be a minimum of [2 feet](#) in width and shall be thermally bonded to the geotextile component of the geocomposite.

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3.1.4 Stacked Geosynthetic Drainage Layers

When geosynthetic drainage layers are to be stacked, roll ends and edges shall be staggered so that joints do not lie above one another.

3.1.5 Corners

In the corners of landfill liner side slopes, an extra layer of drainage layer material shall be installed from the top to the bottom of the slope.

3.1.6 Penetrations

A geotextile apron shall be mechanically attached to pipes and other appurtenances penetrating through the drainage layer so that soil is prevented from getting into the drainage layer. The apron of the attached geotextile shall extend out from the pipe or appurtenance a minimum of 2 feet. The apron geotextile shall be thermally bonded to the geotextile overlying the geonet.

3.2 REPAIRS

3.2.1 Geonet Damage

Repairs shall be made by placing a patch of the geosynthetic drainage layer over the damaged area. The patch shall extend a minimum of 2 feet beyond the edge of the damage. Approved fasteners, spaced every 6 inches around the patch, shall be used to hold the patch in place. If more than 25 percent of the roll width is damaged, approval must be obtained to repair or replace the damaged roll.

3.2.2 Geotextile Damage

Damaged geotextile shall be repaired by placing a patch of geotextile over the damaged area with a minimum of 12 inches of overlap in all directions. The geotextile patch shall be thermally bonded in place.

3.3 PROTECTION AND BACKFILLING

The geosynthetic drainage layer shall be covered with the specified materials within 14 days of acceptance. Cover soil shall be placed from the bottom of the slope upward and shall not be dropped directly onto the drainage layer from a height greater than 3 feet. The cover soil shall be pushed out over the geosynthetic drainage layer in an upward tumbling motion so that wrinkles in the drainage layer do not fold over. No equipment shall be operated on the top surface of the geosynthetic drainage layer without permission from the Contracting Officer. The initial loose soil lift thickness shall be 12 inches. Equipment with ground pressures no greater than 7 psi shall be used to place the first lift of soil. A minimum of 18 inches of soil shall be maintained between construction equipment with a ground pressure greater than 7 psi and the drainage layer. Cover soil compaction and testing requirements are described in Section 31 23 01 98 EXCAVATING.

-- End of Section --

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SECTION 31 10 00

CLEARING FOR CIVIL WORKS

04/06

PART 1 GENERAL

1.1 UNIT PRICES

1.1.1 Clearing (Timber and Structure)

1.1.1.1 Payment

Payment will be made for costs associated with furnishing plant, labor, materials and equipments, and performing all operations necessary for clearing (timber and structures) as specified.

1.1.1.2 Unit of Measure

Unit of measure: lump sum.

1.2 DEFINITIONS

1.2.1 Trees

The line of demarcation between brush and trees, for the purpose of distinguishing clearing requirements, is that trees, as used, will be considered as that woody growth not falling within the limits of brush as defined below.

1.2.2 Brush

Brush is that growth which is less than 2 inches in diameter measured 6 inches from the ground on the uphill side and is less than 6 feet in height measured from the ground on the uphill side.

1.2.3 Structures

The term "structures" shall include buildings or portions thereof, walls, silos, storm or root cellars, cisterns, wells, windmills, pit silos, water towers, etc. Structures shall be removed or filled to the ground surface.

1.3 PROJECT/SITE CONDITIONS

1.3.1 Aesthetics and Pollution Control

1.3.1.1 Ground Areas

All ground areas in the zone of normal pool level fluctuations which are disturbed by clearing operations and which would become subject to erosion will be protected or restored.

1.3.1.2 Construction Roads

All construction roads proposed for use by the Contractor for removing salvaged timber or for access to the work area shall be approved, as to location and alignment, prior to construction. Where such roads are

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determined to be of no value to project operation or will not serve recreational access needs after project construction, the areas occupied by these roads will be restored as nearly as possible to pre-construction conditions by reasonable grading and seeding of a native cover crop along with the planting of seedling trees if in a tree cover area.

1.3.2 Existing Conditions

1.3.2.1 Boundaries

The area to be cleared under this contract is having the general limits as defined below and as indicated on the drawings, which form a part of this contract.

1.3.2.2 Zones

The boundaries of the zones are as described in paragraph BOUNDARIES.

1.3.2.3 Fences

- a. No clearing of fences is required; however, the Contractor may, at his option, remove any or all fence materials from the area and dispose of such materials off the reservoir area.

1.3.2.4 Structures

Combustible materials obtained from removal of structures shall be burned in accordance with paragraph DISPOSAL OF MATERIAL or disposed of off the reservoir area. Where filling of structures is required, fill to within 18 inches of the ground surface shall be made with noncombustible materials such as masonry rubble, and other debris. When all available debris has been used in filling, all remaining unfilled portions, together with the above 18 inches shall be completely filled to the ground surface with earth, borrowed as directed by the Contracting Officer. The top surfaces of fills shall be neat in appearance and smooth enough not to constitute a hazard to persons or livestock.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

3.1 CLEARING REQUIREMENTS

3.1.1 Brush

The cutting of brush is not required.

3.1.2 Zone 1

All trees and stumps, not defined as brush, as indicated on the Drawings.

3.1.3 Equipment

A tree crushing machine may be used at the option of the Contractor in all clearing operations.

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3.2 DISPOSAL OF MATERIAL

3.2.1 General

The material cleared from the areas shall be completely removed by transporting from the Government property or burned within the cleared areas unless otherwise approved by the Contracting Officer. All timber from which saw logs, posts, ties or cordwood can be produced will become the property of the Contractor and in the interest of conservation it is required that the Contractor make a reasonable effort to dispose of material for these purposes. The Contractor may cut timber into convenient lengths at the site but approval must be secured prior to the operation of saw mills within the Government lands. In no case shall cleared material be thrown into or left in the creeks or river. All felled timber shall be completely removed. The cutting of branches and debris remaining after clean-up, to reduce their length in order to avoid removal, will not be permitted.

3.2.2 Removal from Site

Except as otherwise provided, the Contractor will be permitted to remove felled and trimmed timber from the site of the work. The Government will assume no responsibility for the protection and safekeeping of such material. All stockpiled timber must be removed from Government lands before final acceptance of the work will be made.

3.3 DEBRIS

Noncombustible debris in excess of that disposed of as set forth in paragraph STRUCTURES shall be disposed of at such locations below elevation 215 M as may be designated by the Contracting Officer. Debris shall include trash of all kinds.

3.4 MARKETABLE MATERIALS

Any of the cleared materials which the Contractor considers marketable shall become his property and shall be removed from the area.

-- End of Section --

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SECTION 31 23 01.98

EXCAVATING, BACKFILLING, AND COMPACTING FOR STRUCTURES

04/06

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 145	(1991; R 2003) Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes
AASHTO M 218	(2003) Steel Sheet Zinc-Coated (Galvanized) for Corrugated Steel Pipe
AASHTO T 103	(1991; R 2000) Soundness of Aggregates by Freezing and Thawing
AASHTO T 180	(2001; R 2004) Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and an 457-mm (18-in) Drop
AASHTO T 2	(2000) Sampling of Aggregates
AASHTO T 87	(1986; R 2000) the Dry Preparation of Disturbed Soil and Soil Aggregate Samples for Test

ASTM INTERNATIONAL (ASTM)

ASTM C 117	(2004) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C 131	(2006) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 136	(2006) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C 32	(1993; R 1999e1) Standard Specification for Sewer and Manhole Brick (Made from Clay or Shale)
ASTM C 33	(2003) Standard Specification for Concrete Aggregates
ASTM C 387	(2000e1) Standard Specification for

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	Packaged, Dry, Combined Materials for Mortar and Concrete
ASTM C 88	(2005) Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM D 1556	(2000) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(2002e1) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft ³) (2700 kN-m/m ³)
ASTM D 2216	(1998) Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D 226	(1997a) Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing
ASTM D 227	(1997a) Standard Specification for Coal-Tar-Saturated Organic Felt Used in Roofing and Waterproofing
ASTM D 2922	(2001) Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 3282	(1993; R 1997e1) Standard Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes
ASTM D 3740	(2001) Standard Practice for Evaluation of Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used In Engineering Design and Construction
ASTM D 422	(1963; R 2002e1) Particle-Size Analysis of Soils
ASTM D 4318	(2005) Liquid Limit, Plastic Limit, and Plasticity Index of Soils

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1926	Safety and Health Regulations for Construction
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1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

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Construction Equipment List shall be submitted.

Contractor shall record Existing Conditions prior to starting work in accordance with the paragraph entitled, "Existing Conditions," of this section.

SD-06 Test Reports

Test Reports shall be submitted for Soil Test results within 7 calendar days. Test reports shall be submitted according to paragraph entitled, "Quality Control Testing During Construction," of this section.

SD-07 Certificates

Certificates of Compliance for Proposed Soil Materials shall be submitted according to paragraph entitled, "Tests for Proposed Soil Materials," of this section.

1.3 LIMITS OF CONSTRUCTION

Work in this section relates to excavation, fill, and backfill to a point 5 feet beyond the building or structure line.

1.4 SAMPLING AND TESTING

1.4.1 Soil Test and Inspection Service

Soil survey for satisfactory soil materials and samples of soil materials shall be furnished by the Contractor. A certified soil-testing service approved by the Contracting Officer shall be provided by the Contractor. Testing shall include soil survey for satisfactory soil materials; sampling and testing soil materials proposed for use in the work, and field-testing facilities for quality control during construction period.

Testing agencies shall conform to the requirements of ASTM D 3740.

1.4.2 Tests For Proposed Soil Materials

Materials shall be approved by the Contracting Officer prior to start of work.

Soil materials proposed for use in the work shall be tested as follows.

<u>MATERIAL</u>	<u>REQUIREMENT</u>	<u>TEST METHOD</u>	<u>NUMBER OF TESTS</u>
Satis- factory soil materials	Sampling	AASHTO T 2	One from each source of materials to determine con- formance to definition of satisfactory soil materials; additional tests whenever there is any apparent change
	Preparation of samples	AASHTO T 87	
	Sieve analysis is of fine and coarse aggre- gates	ASTM C 136	

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<u>MATERIAL</u>	<u>REQUIREMENT</u>	<u>TEST METHOD</u>	<u>NUMBER OF TESTS</u>
	Amount of material passing No. 200 sieve	ASTM C 117	
	Liquid limit	ASTM D 4318	
	Plastic limit and plasticity index	ASTM D 4318	
	Mechanical analysis	ASTM D 422	
	Moisture-density relations	ASTM D 1557	As required to determine moisture-density requirement of materials from each source
	Los Angeles abrasion of coarse aggregates	ASTM C 131	One for each soil material from each source if called for in reference specification
	Freezing and thawing soundness of aggregates	AASHTO T 103	
	Magnesium Sulfate Soundness Test	ASTM C 88	

1.4.3 Quality Control Testing During Construction

Soil materials shall be tested during construction as follows:

<u>MATERIAL</u>	<u>REQUIREMENT</u>	<u>TEST METHOD</u>	<u>NUMBER OF TESTS</u>
Soil materials specified	Sieve analysis of fine and coarse aggregates	ASTM C 136	One daily for each soil material from each source; additional test whenever there is any apparent change
	Amount of material passing No. 200	ASTM C 117	

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<u>MATERIAL</u>	<u>REQUIREMENT</u>	<u>TEST METHOD</u>	<u>NUMBER OF TESTS</u>
	sieve		
	Moisture content of subbase material	ASTM D 2216	
Soil materials prior to compaction	Moisture-density relations of soil	ASTM D 1557	One of each type of subgrade soil material except under backfill for structures; one for each backfill and fill material from each source
Soil material-in-place after compaction	Density of soil-in-place	ASTM D 1556, Sand Cone Method or ASTM D 2922, Nuclear Method (when approved by Contracting Officer)	At least three daily for each subgrade soil material except under backfill for structures, and for each layer and backfill and fill material; additional test whenever there is any change in moisture conditions

1.4.4 Test Reports

No soil material shall be used until test reports have been reviewed and approved.

1.4.5 Evaluation of Test Results

Results of density of soil-in-place tests shall be considered satisfactory if the average of any group of four consecutive density tests which may be selected is in each instance equal to or greater than the specified density, and if not more than one density test in five has a value more than 2 percentage points below the specified density.

1.5 CONSTRUCTION EQUIPMENT LIST

Construction Equipment List of all major equipment to be used shall be submitted.

1.6 EXISTING CONDITIONS

Existing Conditions shall be recorded, in the presence of the Contracting Officer, and shall include all structures and other facilities adjacent to areas of alteration or removal. Such records shall contain the location of

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existing utilities, the elevation of the top of foundation walls, the location and extent of cracks and other damage, and a description of surface conditions that exist prior to the start of work. Copies of the record shall be submitted and the conditions prior to starting work shall be verified.

PART 2 PRODUCTS

2.1 BACKFILL AND FILL MATERIALS

Materials for backfill and fill shall be free of clay clods, rock or gravel larger than 2 inches in any dimension, debris, waste, frozen materials, and other deleterious matter and shall be satisfactory soil materials as follows:

<u>AREA CLASSIFICATION</u>	<u>BACKFILL OR FILL MATERIALS</u>
In excavations, unless otherwise specified	Excavated or borrow material that has been sampled, tested, and approved as "Satisfactory Soil Material"
Against face of structures where footing drains from top of porous fill for footing drains to indicated elevation, and from face of structure a distance equal to three footing drain diameters	Filtering material
Against surfaces having applied waterproofing for a distance of at least 6 inches from surface	Sand
In foundation subdrain trenches over porous fill drain pipe	Filtering material
Under grassed areas	Excavated or borrow material that has been sampled, tested, and approved as "Satisfactory Soil Material"
Under walks, steps, and paved areas	Subbase material or excavated or borrow material that has been sampled, tested, and approved as "Satisfactory Soil Material"
Under building slabs	Drainage fill

2.1.1 Satisfactory Materials

Satisfactory materials shall mean AASHTO M 145, (ASTM D 3282) Soil

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Classification Groups A-1, A-2-4, A-2-5, and A-3.

2.1.2 Unsatisfactory Materials

Unsatisfactory soil materials shall mean **AASHTO M 145**, Soil Classification Groups A-2-6, A-2-7, A-4, A-5, A-6, and A-7, peat and other highly organic soil, and soil materials of any classification that have a moisture content at the time of compaction beyond the range of 1 percentage point below and 3 percentage points above the optimum moisture content of the soil material as determined by moisture-density relations test.

2.2 TOPSOIL

Topsoil shall be any soil removed from the project site which consists of clay or sandy loam.

The topsoil shall be reasonably free from subsoil, clay lumps, brush, objectionable weeds, and other litter, and shall be free from stones, stumps, roots, and other objectionable materials larger than 1 inches in any dimension.

2.3 TOPSOIL BLEND

Where insufficient topsoil is removed from the project site the topsoil removed shall be supplemented with imported topsoil.

2.4 COHESIONLESS MATERIALS

Cohesionless soil materials include gravels, gravel-sand mixtures, sands, and gravelly-sands. Moisture-density relations of compacted cohesionless soils, when plotted on graphs, will show straight lines or reverse-shaped moisture density curves.

2.5 COHESIVE MATERIALS

Cohesive soil materials include clayey and silty gravels, sand-clay mixtures, gravel-silt mixtures, clayey and silty sands, sand-silt mixtures, clays, silts, and very fine sands. Moisture-density relations of compacted cohesive soils, when plotted on graphs, will show normal moisture-density curves.

2.6 SUBBASE MATERIAL

Subbase material shall be a naturally or artificially graded mixture of natural or crushed gravel, crushed stone, or sand.

2.7 DRAINAGE FILL

Drainage fill shall be a washed, uniformly graded mixture of crushed stone or crushed or uncrushed gravel, with 100 percent passing 1-1/2-inch sieve and not more than 5 percent passing No. 4 sieve.

2.8 FILTERING MATERIAL

Filtering material shall conform to **ASTM C 33** and shall be a uniformly graded mixture of natural or crushed gravel, crushed stone, and natural sand, with 100 percent passing 3/8-inch sieve and 2 to 10 percent passing a No. 100 sieve.

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2.9 SAND

Sand shall be natural sand.

2.10 DRAINAGE PIPE AND FITTINGS

Drainage pipe shall be perforated, corrugated metal pipe underdrains, helically or circumferentially corrugated with welded longitudinal seams, hot-dip galvanized after fabrication, not less than 6 inches in diameter, with coupling bands hot-dip galvanized after fabrication, and shall conform to AASHTO M 218.

Fittings shall be of corresponding weight and quality as drainage pipe.

2.11 SEWER BRICK AND MORTAR MATERIALS

Sewer brick shall be standard brick size and shall conform to ASTM C 32, Grade MM.

Mortar materials shall be dry packaged, proportioned for Type M unit masonry mortar, and shall conform to ASTM C 387.

Mixing water for mortar shall be potable.

PART 3 EXECUTION

3.1 PREPARATION

Before earthwork is started, the location of underground utilities shall be carefully verified by hand methods. Utilities to be left in place shall be protected from damage.

Prior to starting any excavation work, Contractor shall submit NASA form C-927 "Excavation Permit" to the COTR.

3.2 UNAUTHORIZED EXCAVATION

Unauthorized excavation shall consist of removal of materials beyond indicated subgrade elevations or side dimensions specified without specific direction and shall be replaced as specified at no additional cost to the Government.

Unauthorized excavation under foundations or retaining walls shall be filled by lowering the bottom elevation of the footing or base to the excavation bottom without altering the approved top elevation.

Elsewhere unauthorized excavations shall be backfilled and compacted as specified for authorized excavations of the same classification.

3.3 SHORING AND BRACING

Shoring and bracing in excavations shall be maintained regardless of the length of time excavations will be open. Shoring and bracing shall be carried down with the excavation.

Wherever subsequent removal of sheet piling could permit the lateral movement of soil under adjacent structures, steel sheet piling or pressure-creosoted timber sheet piling shall be used and left permanently in place, cut off as required.

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3.4 WATER REMOVAL

Water shall not be permitted to accumulate in excavations, or flood the site and surrounding area. Dewatering systems shall be provided by the Contractor to convey water away from excavations so that softening of foundation bottoms, footing undercutting, and soil changes detrimental to subgrade stability and foundation will not occur. Dewatering systems and methods of disposal shall be approved by the Contracting Officer.

Dewatering shall be continued until construction subject to water pressure has obtained full specified strength and backfill is completed.

Water removal from excavations shall be conveyed to approved collecting or runoff areas. Temporary drainage ditches and other diversions as necessary shall be provided and maintained outside of excavation limits.

Trench excavations for utilities shall not be used for temporary drainage ditches.

3.5 MATERIAL STORAGE

Excavated materials classified as satisfactory soil material shall be stockpiled, where directed, until required for backfill or fill. Stockpiles shall be placed, graded, and shaped for proper drainage.

Materials required in the work shall be located and retained a sufficient distance from the edge of excavations to prevent such material falling or sliding back into the excavations and to prevent cave-ins.

3.6 EXCAVATION FOR STRUCTURES

Excavation for structures shall conform to the dimensions and elevations indicated within a tolerance of plus or minus 0.10 foot and shall extend a sufficient distance from footings and foundations to permit placing and removal of concrete formwork, installation of services and other construction indicated, and for inspection.

In excavating for footings and foundations, care shall be taken not to disturb the bottom of the excavation. Excavation to final grade shall be done just before concrete is placed. Bottoms shall be trimmed to the required lines and grades to leave a solid bed to receive concrete.

For pile foundations, excavation shall stop at an elevation of from 6 to 12 inches above the bottom of the footing before piles are driven. After pile driving has been completed, loose and displaced material shall be removed and excavation to final grade shall be done, leaving a solid bed to receive concrete.

3.7 EXCAVATION FOR FOUNDATION SUBDRAINAGE SYSTEM

Contractor shall adhere to and enforce precautions as outlined in OSHA Regulations, 29 CFR 1926.

Excavation for foundation subdrainage system, except for footing drains located in the excavations for footings and foundations, shall have vertical sides for a vertical dimension above the bottom of the trench not less than two times the outside dimension of the drain pipe, and shall have a clear horizontal distance between the drain pipe barrel and the trench

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wall, on both sides, of not less than 6 inches nor more than 9 inches. Bottom of the trench excavations shall be graded to obtain the required slope and shall be tamped to provide a firm bed for the drain pipe bedding material.

3.8 REMOVAL OF UNSATISFACTORY SOIL MATERIALS

Unsatisfactory soil materials encountered that extend below the required elevations shall be excavated to the depth directed.

3.9 REMOVAL OF EXISTING UNDERGROUND UTILITIES

Existing underground utilities indicated to be removed shall be demolished and completely removed from the excavation.

3.10 CLOSING ENDS OF ABANDONED UNDERGROUND UTILITIES

Open ends of abandoned underground utilities to remain shall be closed to prevent water that may accumulate in such utilities from flowing into excavated areas. Closures shall withstand any hydrostatic or earth pressure that may result after ends of the abandoned utilities have been closed.

Open ends of abandoned underground utilities to remain shall have brick masonry bulkheads constructed to completely close the openings.

Mortar shall be mixed with water for workability by methods that can be controlled and accurately maintained during work progress. Retempering of mortar will not be permitted. Mortar mixing and conveying equipment shall be kept clean. Mortar shall not be deposited or permitted to contact the ground.

Brick shall be wet when laid. Brick shall be laid in mortar so as to form full bed with ends and side joints in one operation and with joints not more than 3/8-inch wide. Fresh masonry work shall be protected from freezing and from too rapid drying from effects of sun and wind. Protection shall be maintained until mortar has set.

Open ends of metallic conduit and pipe shall be closed with threaded galvanized metal caps or plastic plugs or other approved method suitable for the type of material and size of pipe. Wood plugs will not be permitted.

3.11 FOUNDATION SUBDRAINAGE SYSTEM

Foundation subdrainage system outlets shall drain by gravity to free outfall until connected to the storm-drainage system.

3.11.1 Impervious Fill At Footings

After concrete footings have been cured as specified, impervious fill at least 6 inches in depth and 12 inches in width shall be placed on the subgrade adjacent to the bottom of footing and shall be compacted at optimum moisture content by means of hand tampers to not less than the density specified for cohesive material. Impervious fill shall be clayey soil material conforming to AASHTO M 145, Soil Classification Groups A-2-6 and A-2-7.

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3.11.2 Laying Drain Pipe

Drain pipe shall be laid with the perforations down and firmly bedded in specified drainage fill material, with each pipe section having full bearing throughout its length to true grades and alignment and continuous fall in the direction of flow. One-eighth bends shall be used for changes in direction; Y-fittings shall be used at intersections. Drain pipe joints shall be closed.

Recesses in the excavation bottom shall be excavated to receive bells for drain pipe having bell and spigot ends. Such pipe shall be laid with bells facing up the slope and with spigot end entered fully into the adjacent bell.

3.11.3 Testing Drain Lines

Drain lines shall be tested with water before backfilling to ensure free flow. Any obstruction encountered shall be removed, damaged components replaced, and system retested until satisfactory.

3.11.4 Porous Fill Over Drain Pipe

After drain lines have been tested, drain pipe shall be backfilled to a width of at least 4 inches on sides and 12-inches above the top of pipe with specified drainage fill material. Fill material shall be placed in layers not exceeding 3 inches in loose depth and compacted with not less than two passes of a hand-operated platetype vibrating compactor. Fill material shall be overlaid with one layer of 15-pound per 100 square foot asphalt or tar-saturated felt conforming to ASTM D 226 or ASTM D 227, respectively.

3.12 FILLING AND BACKFILLING

3.12.1 Preparations Prior to Backfill Placement

Excavations shall be backfilled as promptly as the work permits but not until completion of the following:

- Approval of construction below finish grade

- Inspection, testing, approval, and recording location of underground utilities

- Removal of concrete formwork

- Removal of shoring and bracing; backfilling of voids with satisfactory soil material; temporary sheet piling driven below bottom of structures; and cutting off and removing of utilities in a manner that prevents settlement of the structure or utilities

- Removal of trash and debris

- Completion of concrete waterproofing

3.12.2 Preparation of Ground Surface to Receive Fill

Vegetation, debris, unsatisfactory soil materials, obstructions, and deleterious materials shall be removed from ground surface prior to the placement of fills. Sloped surfaces steeper than 1 vertical to 4

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horizontal shall be plowed, stripped, or broken up in such manner that fill material will bond with the existing material.

When the ground surface has a density less than that specified for the particular area classification, the ground surface shall be broken up, pulverized, moisture-conditioned to near optimum moisture content of the soil material, and compacted to the required depth and percentage of maximum density.

3.12.3 Placement and Compaction

Backfill and fill materials shall be placed in layers not more than 6 inches in loose depth. Before compaction, each layer of backfill or fill material shall be moistened or aerated as necessary to provide the optimum moisture content of the soil material and shall then be compacted to the percentage of maximum density for each area classification as specified. Backfill or fill material shall not be placed on surfaces that are muddy, frozen, icy, or contain frost.

Backfill and fill materials adjacent to structures shall be brought up evenly around structures and shall be carried up to the indicated elevations.

Compaction adjacent to structures, within a horizontal distance from the face of the structure equal to the depth of backfill or fill material (measured from the bottom of footing or bottom of foundation or retaining wall) to final grade, shall be done with power-driven hand tampers.

3.13 COMPACTION

Degree of compaction required is expressed as a percentage of the maximum density obtained by the test procedure in AASHTO T 180, Methods B or D.

3.13.1 Moisture Control

Moisture content in soil material at time of compaction shall be within limits specified.

Where the moisture content of a layer of soil material is below optimum before compaction, the required amount of water shall be uniformly applied to the surface of the layer of soil material and the layer of soil disked or otherwise mixed until a uniform moisture content is reached.

Moisture of a layer of soil material that is above optimum shall be removed by drying.

3.14 GRADING

Areas within the limits of grading under this section, including adjacent transition areas, shall be uniformly graded. Finished surface shall be smooth within the specified tolerances, compacted, and with uniform levels or slopes between points where elevations are indicated or between such points and existing grades.

3.14.1 Grading Outside Building Lines

Areas outside the building lines for each structure shall be hand-graded to drain away from the structure and to prevent ponding of water after rains. Finished surface shall be within the tolerance specified below for each

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area classification, compacted as specified, and free from irregular surface changes.

Grassed or planted areas:

Finished surface of areas to receive topsoil blend shall be not more than 0.10 foot above or below the indicated finish elevations.

Walks:

Surface of areas under walks shall be shaped to line, grade, and cross section; finished surface shall be not more than 0.0 foot above or 0.10 foot below the indicated finish elevation.

Pavements:

Surface of areas under pavements shall be shaped to line, grade, and cross section; the finished surface shall be not more than 1-inch above or below the indicated finish elevation when tested with a 10-foot straightedge applied both parallel with and at right angles to the centerline of the area. Finished surface shall vary no more than 1 inch.

3.14.2 Grading Surface of Fill Under Structures

Surface of fill under building slabs shall be smooth and even, free of voids, compacted as specified and to indicated grade within the specified tolerances. When tested with a 10-foot straightedge, parallel with and at right angles to the building lines, the finished surface shall show no deviation in excess of 1 inch.

3.15 MAINTENANCE

3.15.1 Protection of Graded Areas

Newly graded areas shall be protected from traffic and erosion and shall be maintained free of trash and debris.

3.15.2 Reconditioning Compacted Areas

Where approved compacted areas are disturbed by subsequent construction operations or adverse weather, the surface shall be scarified, reshaped, and compacted as specified to the required density prior to further construction.

3.16 DISPOSAL OF EXCESS AND WASTE MATERIALS

Excess excavated satisfactory materials shall be removed from Government property.

Waste materials, including excavated material classified as unsatisfactory soil material, trash, and debris, shall be removed from Government property and legally disposed at no additional cost to the Government. .

-- End of Section --

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SECTION 31 23 02.98

EXCAVATION, BACKFILLING, AND COMPACTING FOR UTILITIES

04/06

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

- | | |
|--------------|--|
| AASHTO M 145 | (1991; R 2003) Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes |
| AASHTO T 180 | (2001; R 2004) Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and an 457-mm (18-in) Drop |
| AASHTO T 2 | (2000) Sampling of Aggregates |
| AASHTO T 87 | (1986; R 2000) the Dry Preparation of Disturbed Soil and Soil Aggregate Samples for Test |

AMERICAN WOOD-PRESERVERS' ASSOCIATION (AWPA)

- | | |
|---------|---|
| AWPA C1 | (2003) All Timber Products - Preservative Treatment by Pressure Processes |
| AWPA C3 | (1988) Piles - Preservative Treatment by Pressure Processes |

ASTM INTERNATIONAL (ASTM)

- | | |
|-------------|--|
| ASTM C 136 | (2006) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates |
| ASTM D 1556 | (2000) Density and Unit Weight of Soil in Place by the Sand-Cone Method |
| ASTM D 2922 | (2001) Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth) |
| ASTM D 3740 | (2001) Standard Practice for Evaluation of Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used In Engineering Design and Construction |
| ASTM D 422 | (1963; R 2002e1) Particle-Size Analysis of Soils |

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ASTM D 4318

(2005) Liquid Limit, Plastic Limit, and
Plasticity Index of Soils

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Record of Existing Conditions shall be submitted in accordance with the paragraph entitled, "Records of Existing Conditions," of this section.

The records shall include the following:

Location of Underground Utilities
Location of Approved Utilities
Location of Test
Location of Inspection

SD-02 Shop Drawings

Design of trench shields shall be done by registered professional engineer and sealed drawings of designed trench shoring shall be provided as shop drawing.

As-Built Drawings shall be submitted in accordance with paragraph entitled, "Drawings," of this section.

SD-06 Test Reports

Test reports shall be submitted in writing by the Contractor for Soil Test results within 5 calendar days. Reports shall be according to the paragraph entitled, "Field Quality Control," of this section.

SD-07 Certificates

Certificates for the following shall be submitted by the Contracting Officer in accordance with the paragraph entitled, "Plans," of this section.

Demolition Plan
Work Plan
Protection Plan

Certificates for Proposed Soil Materials shall be submitted by the Contracting Officer in accordance with paragraph entitled, "Proposed Soil Materials," of this section.

1.3 QUALITY ASSURANCE

Soil survey for satisfactory soil materials and samples of soil materials shall be furnished by the Contractor. A certified soil-testing service approved by the Contracting Officer shall be provided by the Contractor. Testing shall include soil survey for satisfactory soil materials, sampling

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and testing soil materials proposed for use in the work, subbase materials at the mixing plant, and field-testing facilities for quality control during construction period.

Testing agencies shall conform to the requirements of [ASTM D 3740](#).

1.4 PLANS

The [Demolition Plan](#) shall be approved by the Contracting Officer at least 48 hours in advance of the work. The plan shall include all special environmental consideration and safety precautions along with the coordination procedures for the protection plan and work plan of this phase of work.

A [Work Plan](#) shall be submitted including proposed methods of excavation, earth support, utility construction, and backfilling at least 48 hours in advance of the work, for approval by the Contracting Officer. The plan shall be coordinated with the demolition and protection plans of this section.

The Contractor shall provide a [Protection Plan](#) of existing utilities place, and coordinate the plan with the demolition plan.

1.5 DRAWINGS

[As-Built Drawings](#) shall be submitted in accordance with Section [01 78 00.98](#), "CLOSEOUT SUBMITTALS."

1.6 RECORDS OF EXISTING CONDITIONS

The Contractor shall verify the existing conditions are correct as shown on the plans and mentioned in the specification. Any discrepancies found shall be noted immediately, and notification given to the Contracting Officer. Contractor shall contact Ohio Utility Protection Services and utilize NASA Facility Engineering to ascertain location of existing buried features.

The records shall include [Location of Underground Utilities](#), [Location of Approved Utilities](#), [Location of Test](#) and [Location of Inspection](#).

PART 2 PRODUCTS

2.1 STRUCTURAL MATERIALS

Materials used for shoring and bracing, such as sheet piling, uprights, stringers, and crossbraces, shall be in good serviceable condition. Any timber used shall be sound and free from large or loose knots.

Pressure-treated timber shall be used where wood sheeting or piling is specified or indicated to be cut and left in place. Timber and treatment shall conform to [AWPA C1](#). Pressure treatment for piles shall conform to [AWPA C3](#). Creosote retention shall be not less than [2 pounds per cubic foot](#). Chromate Copper Arsenate (CCA) retention shall be not less than [0.8 pounds per cubic foot](#).

Submit sealed drawings of designed trench shoring.

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2.2 MANUFACTURED SHORING

Provide aluminum or steel trench shields from reputable manufacturer who has components certified by professional engineer to comply with OSHA.

2.3 BACKFILL MATERIAL

Backfill material shall consist of sandy clay, sand, gravel, soft shale, or other satisfactory soil materials.

2.3.1 Proposed Soil Materials

Soil materials proposed for use in the work shall be tested. The materials shall be approved by the Contracting Officer prior to start of work, as follows:

<u>MATERIAL</u>	<u>REQUIREMENT</u>	<u>TEST METHOD</u>	<u>NUMBER OF TESTS</u>
Satisfactory soil materials	Sampling	AASHTO T 2	One for each source of material to determine conformance to definition of satisfactory soil materials; additional tests whenever there is any apparent change
	Preparation of samples	AASHTO T 87	
	Sieve analysis of fine and coarse aggregate	ASTM C 136	
	Mechanical analysis of soils	ASTM D 422	
	Liquid limit of soils	ASTM D 4318	
	Plastic limit and plasticity index of soils	ASTM D 4318	
	Moisture-density relations of soil	AASHTO T 180, Method B or D	

2.3.2 Satisfactory Materials

Satisfactory soil materials - AASHTO M 145 Soil Classification Groups A-1, A-2-4, A-2-5, and A-3.

2.3.3 Unsatisfactory Materials

Unsatisfactory soil materials - AASHTO M 145 Soil Classification Groups A-2-6, A-2-7, A-4, A-5, A-6, and A-7, highly organic soils, and soil materials of any classification that have a moisture content at the time of compaction beyond the range of 1 percentage point below and 3 percentage points above the optimum moisture content of the soil material as determined by moisture-density relations test.

2.4 TOPSOIL

Topsoil shall be any soil removed from the project site which consists of

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clay or sandy loam. The topsoil shall be reasonably free from subsoil, clay lumps, brush, objectionable weeds, and other litter, and shall be free from stones, stumps, roots, and other objectionable materials larger than 1 inch in any dimension.

2.5 TOPSOIL BLEND

Where insufficient topsoil is removed from the project site the topsoil removed shall be supplemented with imported topsoil.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

Before starting earthwork, the location of underground utilities shall be carefully verified by hand methods. Utilities to be left in place shall be protected from damage.

Prior to starting any excavation work, Contractor shall submit NASA form C-927 "Excavation Permit" to the COTR.

Excavation, filling, backfilling, and grading shall be to subgrade elevations specified.

Excavated materials suitable for backfill shall be piled in an orderly manner sufficiently distant from excavations to prevent overloading, slides, and cave-ins.

Excavations shall be done in ways that will prevent surface water and subsurface water from flowing into excavations and will also prevent flooding of the site and surrounding area.

3.2 PROTECTION OF PERSONS AND PROPERTY

Excavations shall be barricaded and posted with warning signs for the safety of persons. Warning lights shall be provided during hours of darkness.

Structures, utilities, sidewalks, pavements, and other facilities immediately adjacent to excavations shall be protected against damage including settlement, lateral movement, undermining, and washout.

Topsoil removal operations shall be conducted to ensure safety of persons and to prevent damage to existing structures and utilities, construction in progress, trees and vegetation to remain standing, and other property.

3.3 SHORING, BRACING, AND SHEETING

Shoring and bracing in excavations shall be maintained for the entire length of time excavations will be open. Shoring and bracing shall be carried down with the excavation.

Sheeting used to prevent lateral movement of soil shall be removed in accordance with the requirements.

Untreated sheeting shall not be left in place beneath structures or pavements.

Design of trench shields shall be done by registered professional engineer

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and sealed drawings of designed trench shoring shall be provided as shop drawing.

3.4 TRENCH EXCAVATION

Trenches shall be of adequate width and depth for the specified purpose. Side slopes of the trenches shall be as nearly vertical as practicable. Care shall be taken not to overexcavate. Bottoms of the trenches shall be accurately graded to provide uniform bearing and support for sand bed. Bell holes and depressions shall be only of such length, depth, and width as required to make the joint. Stones shall be removed, as necessary, to avoid point bearing. Where rock excavation is required in trenches for pipe, the rock shall be excavated to a minimum overdepth of 6-inches below the trench depth specified. Except as specified for wet or otherwise unstable material, overdepths shall be backfilled with materials specified for backfilling the lower portion of trenches. Whenever wet or otherwise unstable material that is incapable of properly supporting the pipe, as determined by the Contracting Officer, is encountered in the bottom of the trench, it shall be removed and the trench shall be backfilled to the proper grade with coarse sand, fine gravel, or other suitable, approved material.

Trench excavations in surfaced areas shall be by open cut, unless otherwise shown. The pavement shall be cut by concrete saw or other approved method. Cuts shall be in straight lines parallel to the utility line location and shall be to a depth of at least one quarter of the pavement thickness. The remainder of the pavement shall be broken out. Pavement shall be removed a minimum of 12 inches on each side of the trench and 6 inches beyond where the base course is to be removed.

3.5 WATER REMOVAL

Water shall not be permitted to accumulate in excavations. Dewatering systems shall be provided by the Contractor to convey water away from excavations so that softening of foundation bottoms, footing undercutting, and soil changes detrimental to subgrade stability and foundation will not occur. Dewatering systems and methods of disposal shall be approved by the Contracting Officer.

Dewatering shall be continued until construction subject to water pressure has obtained full specified strength and backfill is completed.

Water removal from excavations shall be conveyed to approved collecting or runoff areas. Temporary drainage ditches and other diversions as necessary shall be provided and maintained outside of excavation limits.

Trench excavations for utilities shall not be used for temporary drainage ditches.

3.6 EXCAVATION FOR SANITARY SEWERS AND STORM SEWERS

The width of the trench at and below the top of the pipe shall be such that the clear space between the barrel of the pipe and the trench wall shall not exceed 8 inches or be less than 5 inches on either side of the pipe. The width of the trench above that level shall be as wide as necessary for sheeting and bracing and for the proper performance of the work.

Depth of excavation for gravity sewer lines shall permit the installation of the pipe at the flow line elevations shown on the plans.

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3.7 EXCAVATION FOR WATER DISTRIBUTION SYSTEM

Trenches shall be graded to avoid high points that necessitate placing vacuum and relief valves in the waterlines. If a profile of the pipes is not provided, trenches shall be of a depth to provide a minimum cover over the top of the pipe of 4-1/2 feet from the existing ground surface or the indicated finished grade (whichever is lower) and at additional depth if necessary to avoid interference of the waterlines with other utilities.

3.8 EXCAVATION FOR GAS DISTRIBUTION SYSTEM

Trenches for gas distribution lines shall be excavated to a depth that will provide not less than 2 feet of cover over the top of the pipe from the existing ground surface or from the indicated finished grade (whichever is lower).

3.9 EXCAVATION FOR ELECTRICAL UTILITIES

Excavation of trenches for electrical cables and duct lines shall provide vertical walls, unless otherwise approved by the Contracting Officer, and the trench shall be only as wide as necessary for workers to install the cables or ducts. Abrupt changes in grade of the trench bottom shall be avoided. Trenches shall be of a depth to provide a minimum cover over the top of the cables or ducts of 2-feet below finished grade, and at additional depth if necessary to avoid interference of the electrical cables or ducts with other utilities.

3.10 EXCAVATION FOR APPURTENANCES

Excavation for manholes and similar structures shall be sufficient to leave at least 12 inches in the clear between the outer surfaces and the embankment or timber used to hold and protect the walls. Any overdepth excavation below such appurtenances that has not been directed will be considered unauthorized and shall be refilled with select bedding material or concrete, as directed by the Contracting Officer, at no additional cost to the Government.

3.11 BORING AND JACKING

Where utilities beneath concrete and asphaltic pavement shall be installed by boring and jacking, The boring and jacking installation shall be performed by workers experienced in such operations, with equipment designed and regularly used for this work. The bored opening shall be kept to the minimum size practical for the installation of the utility. When a void greater than 1 inch exists between the bored opening and outside edge of the utility installation, the void shall be filled with grout under pressure, as approved by the Contracting Officer.

3.12 BACKFILLING AND COMPACTION

Where trench sheeting is pulled, withdrawal shall be in increments of not more than 1 foot and backfilling and compaction operations shall be carried on simultaneously with trench sheeting pulling.

Trenches shall not be backfilled until required tests are performed and until the utilities systems, as installed, conform to the requirements for the installation of the various utilities. Trenches improperly backfilled shall be reopened to the depth required for proper compaction, then

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refilled and compacted as specified, or the condition shall be otherwise corrected as directed.

3.12.1 Bedding

Where the trench is excavated in rocks, a minimum of 6 inches of specified bedding material shall be placed on the rock surface before laying conduit or electrical cable.

3.12.2 Backfill Around Pipe

Pipe shall be bedded in sand and up to the centerline of the pipe shall be sand.

3.12.3 Lower Portion of Trench

Except as shown on the drawings for trenches within 2 meters of paving, lower portion of trench shall be satisfactory materials to top of pipe, compacted to 90 percent Procter. For trenches within 2 meters of paving, provide flowable fill.

3.12.4 Remainder of Trench

The remainder of the trench shall be backfilled with material that is free of stones larger than 3 inches in any dimension. Backfill material shall be deposited in layers not exceeding the thickness specified, and each layer shall be compacted to the minimum density specified, except as specified herein.

Within 2 meters of future and newly installed paving provide low strength mortar flowable fill. Backfill existing paving shall be as described for other areas.

Other areas:

8-inch layers, 90 percent of maximum density prescribed in AASHTO T 180, Method B or D

3.13 FIELD QUALITY CONTROL

The Contractor shall arrange his Soil Test work so that sampling and testing may be performed without interruption. Moisture-density relations shall be determined in accordance with AASHTO T 180, Method B or D. Field density tests shall be performed by methods in sufficient number to ensure that the specified density is obtained.

Soil materials shall be tested during construction as follows:

<u>MATERIAL</u>	<u>REQUIREMENT</u>	<u>TEST METHOD</u>	MATERIAL TESTED AND
			<u>NUMBER OF TESTS</u>
Soil material-in-place after compaction	Density of soil-in-place	ASTM D 1556, Sand Cone Method or ASTM D 2922, Nuclear Method (when	At least three daily for each subgrade soil material, and for each layer of soil material; addition-

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<u>MATERIAL</u>	<u>REQUIREMENT</u>	<u>TEST METHOD</u>	MATERIAL TESTED
			AND <u>NUMBER OF TESTS</u>
		approved by Con- tracting Officer)	al test when- ever there is in moisture

3.14 RESTORATION OF SURFACES

Areas within the limits of earthwork under this section, including adjacent transition areas, shall be uniformly graded. The finished surface shall be smooth within the specified tolerances, compacted, and with uniform levels or slopes between points where elevations are indicated or between such points and existing grades.

Grassed areas:

The finished surface of areas to receive topsoil blend shall be not more than 0.10-foot above or below the specified finish elevations.

Walks:

The surface of areas under walks shall be shaped to line, grade, and cross section, and the finished surface shall be not more than 0.0 foot above or 0.10-foot below the specified finish elevations.

Pavements:

The surface of areas under pavements shall be shaped to line, grade, and cross section, and the finished surface shall be not more than 1/2-inch above or below the specified finish elevations.

3.15 DISPOSAL OF EXCESS AND WASTE MATERIALS

Excess excavated satisfactory materials shall be transported to, and disposed in, designated storage areas on Government property.

Waste materials, including excavated material classified as unsatisfactory soil material, trash, and debris, shall be removed from Government property and legally disposed of, by the Contractor.

-- End of Section --

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FLOWABLE FILL

04/06

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C 150 (2007) Standard Specification for Portland Cement

ASTM D 4832 (2002) Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders

STATE OF OHIO DEPARTMENT OF TRANSPORTATION (ODOT)

ODOT 613 (2005) Concrete General; and Subparts as Specified

ODOT 701 (2005) Cementitious Materials; and Subparts as Specified

ODOT 705 (2002) Concrete Pavement Incidentals; and Subparts as Specified

1.2 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-07 Certificates

Certificates of Compliance

1.3 Certificates of Compliance

Shall be submitted demonstrating compliance with the mix design specified herein. Certificates must contain project name and Contract number, date, name of Contractor, name of supplier and the mix design data.

PART 2 PRODUCTS

2.1 GENERAL

All materials shall conform to the applicable requirements of ODOT 613, Type 2 Low Strength Mortar Backfill, except that no crushed slag, foundry sand, or fly ash is permitted to be used at GRC.

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2.2 MATERIALS

2.2.1 Cement

Cement shall conform to ODOT 701.01 or ODOT 701.04, (ASTM C 150 Type I or Type II).

2.2.2 Fine Aggregate

Fine aggregate shall be natural sand or sand manufactured from stone or gravel. The sand shall be fine enough to stay in suspension on the mixture to ensure proper flow.

The gradation of the sand shall be:

<u>Sieve Size</u>	<u>Percent Passing</u>
No. 4 (4.75mm)	90-100
No. 50 (300µm)	7-40
No. 200 (75µm)	0-10

It is intended that the sand be fine enough to stay in suspension in the mixture during all placement activities, without segregation. The COTR reserves the right to reject the sand gradation if a flowable mixture is not produced at the project site.

2.2.3 Performance Enhancing Admixture

A performance enhancing admixture shall be incorporated in the mix that shall have the effect of lowering the wet density to a maximum of 1600 kg per cubic meter, a 28-day unconfined compressive strength between 345 and 689 kPA (50 and 100 pounds per square inch); increasing air content to 30% minimum; and shall eliminate bleed water and segregation. This admixture product shall be specifically manufactured for this purpose and shall be used at the recommended design rate. An approved accelerating agent shall be added to the first lift; and may be added to the following lifts if a faster setting time is desired.

2.3 MORTAR DESIGN MIX

The initial mix may be proportioned as follows:

Quantities of Dry Materials per Cubic Meter (Cubic Yard)

Cement	59 kg	(100 lb)
Sand (SSD)*	1,436 kg	(2,420 lb)
Water (Target)	125-178 kg	(210-300 lb)

*saturated surface dry

These quantities of materials are expected to yield approximately one cubic meter (1.308 cubic yard) of material of a flowable consistency. Small adjustments in the amounts of the materials in a mix may be required to achieve the final product. No additional compensation for a change in the material blends shall be allowed. Contractor shall have delivered one or more 1 cubic meter trial batches at different water contents to ensure a flowable material. The mixture is too dry if cracks develop in the mixture

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as it flows into place. A delay in bleeding indicates there are too many fines in the mixture. Contractor shall adjust the proportions to maintain the total absolute volume. Four test cylinders of the trial mix shall be taken and tested for unconfined compressive strength according to [ASTM D 4832](#).

2.4 ALTERNATE MIXES

Other mixes may be submitted to the COTR for approval. The Contractor shall submit the mix design and test data from an independent test lab 30 days prior to the intended usage for approval.

This requirement is for all mixes that:

- a. Vary more than 178 kg (300 pounds) in sand, 59 kg (100 pounds) in water or 12 kg (20 pounds) in cement from the above mixes. These are considered large adjustments.
- b. Have less than 59 kg (100 pounds) of cement in the Type 2 mixes.
- c. Utilizes alternate materials.
- d. Foundry sand, slag, or fly ash shall not be used for any mix.

All alternate mixes shall have an unconfined compressive strength between 345 and 689 kPa (50 and 100 pounds per square inch) at 28 days when tested in accordance with ASTM D 4832. The long term (12 month) unconfined compressive strength shall be less than 689 kPa (100 pounds per square inch).

The final mix shall have the required strength, fill voids of the intended usage and set up within 12 hours. The proportioning, yield, consistency, workability, compressive strength and all other requirements are the sole reasonability of the Contractor.

2.5 MIXING EQUIPMENT

Sufficient mixing capacity and delivery equipment shall be provided for the material to be placed without interruption as much as practical. The Type 2 mix or Type 2 alternate mixes shall be delivered and placed from ready mixed concrete trucks or delivered from a batch plant.

2.6 MIXING THE MATERIALS

The mixture shall be discharged within 2.5 hours after the water is added.

2.7 READY-MIX MORTAR

Low strength mortar backfill shall be supplied by a ready-mix supplier approved by the COTR and delivered to the project site in standard concrete delivery trucks.

PART 3 EXECUTION

3.1 PLACING MORTAR

The flowable material shall be discharged from the mixer by any reasonable means into the space of the plan intended usage. The fill material shall be brought up uniformly to the fill line shown on the plans or as directed

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by the COTR. Placing of the other fill material over low strength mortar backfill material may commence as soon as the surface water is gone or as directed by the COTR. The COTR reserves the right to reject the mix if a flowable mixture is not produced.

Before placing the low strength mortar backfill for the utilities, the Contractor shall secure the utility to prevent it from floating during placement of the flowable material.

3.2 METHOD OF MEASUREMENT

Low strength mortar backfill will be measured by the number of cubic meters (cubic yards) computed from the plan lines, and placed. No additional compensation shall be allowed for over excavated areas.

3.3 TEST CYLINDERS

Test cylinders shall be taken at the rate of four (4) cylinders per day for compressive strength tests by a lab at 7, and 28 days. Test may be discontinued at the discretion of the COTR if tests consistently fall within the specified range of strength.

At the discretion of the quality assurance technician, the Government shall take samples of the LSM and submit the samples to a certified laboratory to perform spectrographic analysis. Test shall be performed to determine that materials used in the LSM mix adhere to this specification.

-- End of Section --

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SECTION 31 32 11

SOIL SURFACE EROSION CONTROL

10/06

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D 1560	(2005e1) Resistance to Deformation and Cohesion of Bituminous Mixtures by Means of Hveem Apparatus
ASTM D 1777	(1996; R 2007) Thickness of Textile Materials
ASTM D 2028	(1997; R 2004) Cutback Asphalt (Rapid-Curing Type)
ASTM D 2844	(2007) Resistance R-Value and Expansion Pressure of Compacted Soils
ASTM D 3776	(2007) Mass Per Unit Area (Weight) of Fabric
ASTM D 3787	(2007) Bursting Strength of Textiles - Constant-Rate-of-Traverse (CRT), Ball Burst Test
ASTM D 3884	(2001; R 2007) Abrasion Resistance of Textile Fabrics (Rotary Platform, Double-Head Method)
ASTM D 4355	(2007) Deterioration of Geotextiles from Exposure to Light, Moisture and Heat in a Xenon-Arc Type Apparatus
ASTM D 4491	(1999a; R 2004e1) Water Permeability of Geotextiles by Permittivity
ASTM D 4533	(2004) Trapezoid Tearing Strength of Geotextiles
ASTM D 4595	(2005) Tensile Properties of Geotextiles by the Wide-Width Strip Method
ASTM D 4632	(1991; R 2003) Grab Breaking Load and Elongation of Geotextiles
ASTM D 4751	(2004) Determining Apparent Opening Size

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of a Geotextile

ASTM D 4833	(2000e1) Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
ASTM D 4972	(2001; R 2007) pH of Soils
ASTM D 5034	(1995; R 2001) Breaking Strength and Elongation of Textile Fabrics (Grab Test)
ASTM D 5035	(2006) Breaking Force and Elongation of Textile Fabrics (Strip Method)
ASTM D 5268	(2007) Topsoil Used for Landscaping Purposes
ASTM D 5852	(2000; R 2007) Standard Test Method for Erodibility Determination of Soil in the Field or in the Laboratory by the Jet Index Method
ASTM D 6629	(2001; R 2007) Selection of Methods for Estimating Soil Loss by Erosion
ASTM D 698	(2007e1) Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/cu. ft. (600 kN-m/cu. m.))
ASTM D 977	(2005) Emulsified Asphalt

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Work sequence schedule
Erosion control plan

SD-02 Shop Drawings

Layout
Obstructions Below Ground
Erosion Control

Scale drawings defining areas to receive recommended materials as required by federal, state or local regulations.

Seed Establishment Period

Calendar time period for the seed establishment period. When there is more than one seed establishment period, the boundaries of the seeded area covered for each period shall be described.

Maintenance Record

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Record of maintenance work performed, of measurements and findings for product failure, recommendations for repair, and products replaced.

SD-03 Product Data

Equipment

A listing of equipment to be used for the application of erosion control materials.

Finished Grade Erosion Control Blankets

Condition of finish grade status prior to installation; location of underground utilities and facilities.

SD-04 Samples

Materials

- a. Geosynthetic and synthetic binding material; 1 quart.
- b. Standard mulch; 2 pounds.
- c. Hydraulic mulch; 2 pounds.
- d. Geotextile fabrics; 6 inch square.
- e. Erosion control blankets; 6 inch square.
- f. Synthetic grid systems; One sample grid.
- g. Articulating cellular concrete block systems; 100 square feet area.
- h. Two color charts displaying the colors and finishes for the articulating cellular block system.

SD-06 Test Reports

Geosynthetic Binders Hydraulic Mulch Geotextile Fabrics Erosion Control Blankets Synthetic Grid Systems Articulating Cellular Concrete Block Systems

Certified reports of inspections and laboratory tests, prepared by an independent testing agency, including analysis and interpretation of test results. Each report shall be properly identified. Test methods used and compliance with recognized test standards shall be described.

Sand Gravel

Sieve test results. Sand shall be uniformly graded.

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SD-07 Certificates

Fill Material
Mulch
Hydraulic Mulch
Geotextile Fabrics

Prior to delivery of materials, certificates of compliance attesting that materials meet the specified requirements. Certified copies of the material certificates shall include the following.

For items listed in this section:

- a. Certification of recycled content or,
- b. Statement of recycled content.
- c. Certification of origin including the name, address and telephone number of manufacturer.

Geosynthetic Binders
Synthetic Soil Binders

Certification for binders showing EPA registered uses, toxicity levels, and application hazards.

Installer's Qualification

The installer's company name and address; training and experience and or certification.

Recycled Plastic

Individual component and assembled unit structural integrity test; creep tolerance; deflection tolerance; and vertical load test results. Life-cycle durability.

Seed

Classification, botanical name, common name, percent pure live seed, minimum percent germination and hard seed, maximum percent weed seed content, and date tested.

Asphalt Adhesive
Tackifier

Composition.

Wood By-Products

Composition, source, and particle size. Products shall be free from toxic chemicals or hazardous material.

Wood Cellulose Fiber

Certification stating that wood components were obtained from managed forests.

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SD-10 Operation and Maintenance Data

Maintenance Instructions

Instruction for year-round care of installed material. The Contractor shall include manufacturer supplied spare parts.

1.3 MEASUREMENT AND PAYMENT

1.3.1 Standard and Geosynthetic Binder

The standard and geosynthetic binder shall be measured by the square yard of surface area covered. No measurement for payment shall be made for fine grading, trenching or other miscellaneous materials necessary for placement of the binder.

1.3.2 Mulch and Compost

Mulch and compost shall be measured by the square yard of surface area covered. No measurement for payment shall be made for binder, dye or other miscellaneous materials or equipment necessary for placement of the mulch or compost.

1.3.3 Hydraulic Mulch

Measure hydraulic mulch by the square yard of surface area covered. Measurement for payment shall include binder, dye or both. No measurement for payment shall be made for other miscellaneous materials or equipment necessary for placement of the hydraulic mulch.

1.3.4 Geotextile Fabric

Measure geotextile fabrics by the square yard of surface area covered. No measurement for payment shall be made for fine grading, trenching or other miscellaneous materials necessary for placement of the fabric.

1.3.5 Erosion Control Blankets

Measure erosion control blankets by the square yard of surface area covered. No measurement for payment shall be made for fine grading, trenching or other miscellaneous materials necessary for placement of the erosion control blankets.

1.3.6 Synthetic Grid/Sheet Systems

Measure synthetic grid/sheet system by the square yard of surface area covered. No measurement for payment shall be made for fine grading, trenching, geotextile, seams, grout, rock, topsoil or other miscellaneous materials necessary for placement of the articulating cellular concrete block system.

1.3.7 Cellular Concrete Block Systems

Measure articulating cellular concrete block system by the square yard of surface area covered. No measurement for payment shall be made for fine grading, trenching, geotextile, seams, grout, rock, topsoil or other miscellaneous materials necessary for placement of the articulating

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cellular concrete block system.

1.4 DESCRIPTION OF WORK

The work consists of furnishing and installing temporary and permanent soil surface erosion control materials to prevent the pollution of air, water, and land, including fine grading, blanketing, stapling, mulching, vegetative measures, structural measures, and miscellaneous related work, within project limits and in areas outside the project limits where the soil surface is disturbed from work under this contract at the designated locations. This work includes all necessary materials, labor, supervision and equipment for installation of a complete system. Coordinate this section with the requirements of Section TURF AND GRASSES.

1.5 DELIVERY, INSPECTION, STORAGE, AND HANDLING

Store materials in designated areas and as recommended by the manufacturer protected from the elements, direct exposure, and damage. Do not drop containers from trucks. Material shall be free of defects that would void required performance or warranty. Deliver geosynthetic binders and synthetic soil binders in the manufacturer's original sealed containers and stored in a secure area.

- a. Furnish erosion control blankets and geotextile fabric in rolls with suitable wrapping to protect against moisture and extended ultraviolet exposure prior to placement. Label erosion control blanket and geotextile fabric rolls to provide identification sufficient for inventory and quality control purposes.
- b. All synthetic grids, synthetic sheets, and articulating cellular concrete block grids shall be sound and free of defects that would interfere with the proper placing of the block or impair the strength or permanence of the construction. Minor cracks in synthetic grids and concrete cellular block, incidental to the usual methods of manufacture, or resulting from standard methods of handling in shipment and delivery, shall not be deemed grounds for rejection.
- c. Seed shall be inspected upon arrival at the jobsite for conformity to species and quality. Seed that is wet, moldy, or bears a test date five months or older, shall be rejected.

1.6 SUBSTITUTIONS

Substitutions will not be allowed without written request and approval from the Contracting Officer.

1.7 QUALITY ASSURANCE

1.7.1 Installer's Qualification

The installer shall be certified by the manufacturer for training and experience installing the material.

1.7.2 Erosion Potential

Assess potential effects of soil management practices on soil loss in accordance with ASTM D 6629. Assess erodibility of soil with dominant soil structure less than 2.8 to 3.1 inches in accordance with ASTM D 5852.

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1.8 SCHEDULING

Submit a construction work sequence schedule, with the erosion control plan a minimum of 30 days prior to start of construction. The work schedule shall coordinate the timing of land disturbing activities with the provision of erosion control measures to reduce on-site erosion and off-site sedimentation. Coordinate installation of temporary erosion control features with the construction of permanent erosion control features to assure effective and continuous control of erosion, pollution, and sediment deposition. Include a vegetative plan with planting and seeding dates and fertilizer, lime, and mulching rates. Distribute copies of the work schedule and erosion control plan to site subcontractors. Address the following in the erosion control plan:

- a. Statement of erosion control and stormwater control objectives.
- b. Description of temporary and permanent erosion control, stormwater control, and air pollution control measures to be implemented on site.
- c. Description of the type and frequency of maintenance activities required for the chosen erosion control methods.
- d. Comparison of proposed post-development stormwater runoff conditions with predevelopment conditions.

1.9 TIME LIMITATIONS

Complete backfilling the openings in synthetic grid systems and articulating cellular concrete block systems a maximum 7 days after placement to protect the material from ultraviolet radiation.

1.10 WARRANTY

Erosion control material shall have a warranty for use and durable condition for project specific installations. Temporary erosion control materials shall carry a minimum eighteen month warranty. Permanent erosion control materials shall carry a minimum three year warranty.

PART 2 PRODUCTS

2.1 BINDERS

2.1.1 Synthetic Soil Binders

Calcium chloride, or other standard manufacturer's spray on adhesives designed for dust suppression.

2.1.2 Geosynthetic Binders

Geosynthetic binders shall be manufactured in accordance with ASTM D 1560, ASTM D 2844; and shall be referred to as products manufactured for use as modified emulsions for the purpose of erosion control and soil stabilization. Emulsions shall be manufactured from all natural materials and provide a hard durable finish.

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2.2 MULCH

Mulch shall be free from weeds, mold, and other deleterious materials. Mulch materials shall be native to the region.

2.2.1 Straw

Straw shall be stalks from oats, wheat, rye, barley, or rice, furnished in air-dry condition and with a consistency for placing with commercial mulch-blowing equipment.

2.2.2 Hay

Hay shall be native hay, sudan-grass hay, broomsedge hay, or other herbaceous mowings, furnished in an air-dry condition suitable for placing with commercial mulch-blowing equipment.

2.2.3 Wood Cellulose Fiber

Wood cellulose fiber shall be 100 percent recycled material and shall not contain any growth or germination-inhibiting factors and shall be dyed with non-toxic, biodegradable dye an appropriate color to facilitate placement during application. Composition on air-dry weight basis: a minimum 9 to a maximum 15 percent moisture, and between a minimum 4.5 to a maximum 6.0 pH.

2.2.4 Paper Fiber

Paper fiber mulch shall be 100 percent post-consumer recycled news print that is shredded for the purpose of mulching seed.

2.2.5 Shredded Bark

Locally shredded material shall be treated to retard the growth of mold and fungi.

2.2.6 Wood By-Products

Wood locally chipped or ground bark shall be treated to retard the growth of mold and fungi. Gradation: A maximum 2 inch wide by 4 inch long.

2.2.7 Asphalt Adhesive

Asphalt adhesive shall conform to the following: Emulsified asphalt, conforming to ASTM D 977, Grade SS-1; and cutback asphalt, conforming to ASTM D 2028, Designation RC-70.

2.2.8 Mulch Control Netting and Filter Fabric

Mulch control netting and filter fabric may be constructed of lightweight recycled plastic, cotton, or paper or organic fiber. The recycled plastic shall be a woven or nonwoven polypropylene, nylon, or polyester containing stabilizers and/or inhibitors to make the fabric resistant to deterioration from UV, and with the following properties:

- a. Minimum grab tensile strength (TF 25 #1/ASTM D 4632), 180 pounds.
- b. Minimum Puncture (TF 25 #4/ASTM D 3787), 75 psi in the weakest direction.

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- c. Apparent opening sieve size of a minimum 40 and maximum 80 (U.S. Sieve Size).
- d. Minimum Trapezoidal tear strength (TF 25 #2/[ASTM D 4533](#)), 50 pounds.

2.2.9 Hydraulic Mulch

Hydraulic mulch shall be made of 100 percent virgin aspen wood fibers. Wood shall be naturally air-dried to a moisture content of 10.0 percent, plus or minus 3.0 percent. A minimum of 50 percent of the fibers shall be equal to or greater than 0.15 inch in length and a minimum of 75 percent of the fibers shall be retained on a 28 mesh screen. No reprocessed paper fibers shall be included in the hydraulic mulch. Hydraulic mulch shall have the following mixture characteristics:

CHARACTERISTIC (typical)	VALUE
pH	5.4 ± 0.1
Organic Matter (oven dried basis),	percent 99.3 within ± 0.2
Inorganic Ash (oven dried basis),	percent 0.7 within ± 0.2
Water Holding Capacity,	percent 1,401

2.2.10 Dye

Dye shall be a water-activated, green color. Pre-package dye in water dissolvable packets in the hydraulic mulch.

2.3 GEOTEXTILE FABRICS

Geotextile fabrics shall be woven of polypropylene filaments formed into a stable network so that the filaments retain their relative position to each other. Sewn seams shall have strength equal to or greater than the geotextile itself. Install fabric to withstand maximum velocity flows as recommended by the manufacturer. The geotextile shall conform to the following minimum average roll values:

Property	Performance	Test Method
Weight		ASTM D 3776
Thickness		ASTM D 1777
Permeability		ASTM D 4491
Abrasion Resistance,	58 percent X	
Type (percent strength retained)	81 percent	ASTM D 3884
Tensile Grab Strength	1,467 N X 1, 933 N	ASTM D 4632
Grab Elongation	15percent X 20percent	ASTM D 4632
Burst Strength	5,510 kN/m ²	ASTM D 3787
Puncture Strength	733 N	ASTM D 4833
Trapezoid Tear	533 N X 533 N	ASTM D 4533
Apparent Opening Size	40 US Std Sieve	ASTM D 4751
UV Resistance @ 500 hrs	90 percent	ASTM D 4355

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2.4 EROSION CONTROL BLANKETS

2.4.1 Erosion Control Blankets Type I

Use Type I blankets for erosion control and vegetation establishment on roadside embankments, abutments, berms, shoulders, and median swales where natural vegetation will provide long term stabilization. Erosion control blankets shall be a machine-produced mat of 100% straw. The blanket shall be of consistent thickness with the straw evenly distributed over the entire area of the mat. cover the blanket on the top side with a photodegradable polypropylene netting having an approximate 1/2 by 1/2 inch mesh and be sewn together on a maximum 1.5 inch centers with degradable thread. The erosion control blanket shall have the following properties:

Material Content

Straw	100 percent with approximately 0.50 lb/yd ² weight
Netting	One side only, lightweight photodegradable with approximately 1.64 lb/1,000 ft ² weight.
Thread	Degradable

Note 1: Photodegradable life a minimum of 2 months with a minimum 90 percent light penetration. Apply to slopes up to a maximum 3:1 gradient.

2.4.2 Erosion Control Blankets Type II

Erosion control blankets shall be a machine-produced mat of 100 percent straw. The blanket shall be of consistent thickness with the straw evenly distributed over the entire area of the mat. Cover the blanket on the top side with a polypropylene netting having an approximate 1/2 by 1/2 inch mesh with photodegradable accelerators to provide breakdown of the netting within approximately 45 days, depending upon geographic location and elevation. Sew the blanket together on a maximum 1.5 inch centers with degradable thread. The erosion control blanket shall have the following properties:

Material Content

Straw	100 percent with approximately 0.50 lb/yd ² weight.
Netting	One side only, photodegradable with photo accelerators and approximately 1.64 lb/1,000 ft ² weight.
Thread	Degradable

NOTE: Photodegradable life a minimum of 10 months with a minimum 90 percent light penetration. Apply to slopes up to a maximum 3:1 gradient.

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2.4.3 Erosion Control Blankets Type III

Type III blankets shall be used for erosion control and vegetation establishment on roadside embankments, abutments, berms, shoulders, and median swales where natural vegetation will provide long term stabilization. Erosion control blanket shall be a machine-produced mat consisting of 70 percent straw and 30 percent coconut fiber. The blanket shall be of consistent thickness with the straw and coconut fiber evenly distributed over the entire area of the mat. Cover the blanket on the top side with heavyweight photodegradable polypropylene netting having UV additives to delay breakdown and an approximate $5/8$ by $5/8$ inch mesh, and on the bottom side with a lightweight photodegradable polypropylene netting with an approximate $1/2$ by $1/2$ inch mesh. Sew the blanket together on 1.5 inch centers with degradable thread. The erosion control blanket shall have the following properties:

Material Content

Straw	70 percent by approximately 0.35 lb/yd^2 .
Coconut Fiber	30 percent by approximately 0.15 lb/yd^2 weight.
Netting	Top side heavyweight photodegradable with UV additives and approximately 3 lb/1,000 ft^2 weight Bottom side lightweight photodegradable with approximately $1.64 \text{ lb/1,000 ft}^2$ weight.

NOTE: Photodegradable life a minimum of 10 months with a minimum 90 percent light penetration. Apply to slopes with a gradient less than 1.5:1.

2.4.4 Erosion Control Blankets Type IV

Erosion control blanket shall be a machine-produced mat of 100 percent straw. The blanket shall be of consistent thickness with the straw evenly distributed over the entire area of the mat. Cover the blanket on the top and bottom sides with lightweight photodegradable polypropylene netting having an approximate $1/2$ by $1/2$ inch mesh. Sew the blanket together on 1.5 inch centers with degradable thread. The erosion control blanket shall have the following properties:

Material Content

Straw	100 percent with approximately 0.5 lb/yd^2 weight.
Netting	Both sides lightweight photodegradable with approximately $1.64 \text{ lb/1,000 ft}^2$ weight.
Thread	Degradable

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Material Content

NOTE: Photodegradable life a minimum of 2 months with a minimum 90 percent light penetration. Apply to slopes with a gradient of less than 1.5:1.

2.4.5 Erosion Control Blankets Type V

Erosion control blanket shall be a machine-produced mat of 100 percent straw. The blanket shall be of consistent thickness with the straw evenly distributed over the entire area of the mat. Cover the blanket on the top side with polypropylene netting having an approximate 1/2 by 1/2 inch mesh with photodegradable accelerators to provide breakdown of the netting within approximately 45 days, depending upon geographic location and elevation. Cover the bottom with a polypropylene netting having an approximate 1/2 by 1/2 inch mesh with photo accelerators. Sew the blanket together on 1.5 inch centers with degradable thread. The erosion control blanket shall have the following properties:

Material Content

Straw	100 percent with approximately 0.5 lb/yd ² weight.
Netting	Top side lightweight photodegradable with photo accelerators with approximately 1.64 lb/1,000 ft ² weight.
Thread	Bottom side lightweight photodegradable with photo accelerators and approximately 1.64 lb/1,000 ft ² weight.

NOTE: Photodegradable life a minimum of 10 months with a minimum 90 percent light penetration. Apply to slopes up to a maximum 2:1 gradient.

2.4.6 Erosion Control Blankets Type VI

Erosion control blanket shall be a machine-produced 100% biodegradable mat with a 100 percent straw fiber matrix. The blanket shall be of consistent thickness with the straw fiber evenly distributed over the entire area of the mat. Cover the blanket on the top side with a 100 percent biodegradable woven natural organic fiber netting. The netting shall consist of machine directional strands formed from two intertwined yarns with cross directional strands interwoven through the twisted machine strands (commonly referred to as a Leno weave) to form an approximate 1/2 by 1/2 inch mesh. Sew the blanket together with biodegradable thread on 1.5 inch centers. The erosion control blanket shall have the following properties:

Material Content

Matrix	100 percent straw fiber with approximately 0.50 lb/yd ² weight
Netting	One side only, Leno woven 100% biodegradable natural organic fiber

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Material Content

Weight approximately 9.3 lb/1,000 ft.

Thread Biodegradable

NOTE: Photodegradable life a minimum of 10 months with a minimum 90 Percent light penetration. Apply to slopes up to a maximum 2:1 gradient.

2.4.7 Erosion Control Blankets Type VII

Erosion control blanket shall be a machine-produced 100 percent biodegradable mat with an herbaceous straw fiber matrix. The blanket shall be of consistent thickness with the straw evenly distributed over the entire area of the mat. Cover the blanket on the top and bottom sides with 100 percent biodegradable woven natural fiber netting. The netting shall consist of machine directional strands formed from two intertwined yarns with cross directional strands interwoven through the twisted machine strands (commonly referred to as a Leno weave) to form an approximate 1/2 by 1/2 inch mesh. Sew the blanket together with biodegradable thread on 1.5 inch centers. The blanket shall have the following properties:

Material Content

Straw 100 percent straw fiber with approximately 0.5 lb/yd² weight.

Netting Top and bottom sides, Leno woven 100% biodegradable natural organic fiber with approximately 9.3 lb/1,000ft² weight.

Thread Biodegradable

Note: Photodegradable life a minimum of 18 months with a minimum 90 percent light penetration. Apply to slopes up to a maximum 1.5:1 gradient.

2.4.8 Erosion Control Blankets Type VIII

Erosion control blanket shall be a machine-produced 100 percent biodegradable mat with a 70 percent herbaceous straw and 30 percent coconut fiber blend matrix. The blanket shall be of consistent thickness with the straw and coconut fiber evenly distributed over the entire area of the mat. Cover the blanket on the top and bottom sides with 100 percent biodegradable woven natural organic fiber netting. The netting shall consist of machine directional strands formed from two intertwined yarns with cross directional strands interwoven through the twisted machine strands (commonly referred to as a Leno weave) to form an approximate 1/2 by 1/2 inch mesh. Sew the blanket together with biodegradable thread on 1.5 inch centers. Straw/Coconut fiber erosion control blanket shall have the following properties:

Material Content

Matrix 70 percent straw fiber with approximately 0.35 lb/yd² weight. 30 percent coconut fiber cured in fresh water with approximately

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0.15 lb/yd² weight.

Netting Both sides woven 100% biodegradable natural organic fiber with approximately 9.3 lbs/1,000 ft² weight.

Thread Biodegradable

NOTE: Photodegradable life a minimum of 24 months with a minimum 90 percent light penetration. Apply to slopes up to a maximum 1.5:1 gradient.

2.4.9 Erosion Control Blankets Type IX (Turf Reinforcement Mat)

Permanent erosion control/turf reinforcement mat is constructed of 100 percent coconut fiber stitch bonded between a heavy duty UV stabilized bottom net, and a heavy duty UV stabilized cusped (crimped) middle netting overlaid with a heavy duty UV stabilized top net. The cusped netting forms prominent closely spaced ridges across the entire width of the mat. The three nettings are stitched together on 1.5 inch centers with UV stabilized polypropylene thread to form a permanent three dimensional structure. The following list contains further physical properties of the turf erosion control mat.

Property	Test Method	Value	Units
Ground Cover	Image Analysis	93	percent
Thickness	ASTM D 1777		0.63 in
Mass Per Unit Area	ASTM D 3776		0.92 lb/sy
Tensile Strength	ASTM D 5035		480 lb/ft
Elongation	ASTM D 5035		percent
Tensile Strength	ASTM D 5035		960 lb/ft
Elongation	ASTM D 5035	31	percent
Tensile Strength	ASTM D 5034		177 lbs
Elongation	ASTM D 5034	22	percent
Resiliency	ASTM D 1777	greater than 80	percent
UV Stability*	ASTM D 4355		151 lbs
		86	percent
Color(permanent net)		UV Black	
Porosity(permanent net) Calculated		greater than 95	percent
Minimum Filament Measured Diameter (permanent net)			0.03 in

NOTE 1: *ASTM D 5034 Tensile Strength and percent Strength Retention of material after 1000 hours of exposure in Xenon-Arc Weatherometer

NOTE 2: Photodegradable life a minimum of 36 months with a minimum 90 percent light penetration. Apply to slopes up to a maximum 1:1 gradient.

2.4.10 Erosion Control Blankets Type X (Turf Reinforcement Mat)

Permanent erosion control/turf reinforcement mat shall be constructed of 100 percent UV stabilized high denier polypropylene fiber sewn between a

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black UV stabilized 1/2 inch mesh polypropylene netting on the top 5 lbs/1000 square ft and a black UV stabilized 5/8 inch mesh polypropylene netting on the bottom 3 lbs/1000 square ft with polypropylene thread. The mat shall be resistant to photo and chemical degradation. The following list contains further physical properties of the turf reinforcement mat.

Property	Test Method	Value	Units
Thickness	ASTM D 1777		0.56 in
Resiliency	100 PSI-3 cycles	94	percent
Mass Per Unit Area	ASTM D 3776		11.2 oz/sq yd
Tensile Strength	ASTM D 4632		35.2 lbs
Elongation	ASTM D 4632	25.5	percent
Tensile Strength	ASTM D 4595		259.2 lbs/ft
Elongation	ASTM D 4595	20.9	percent
Tensile Strength	ASTM D 5035		300 lbs/ft
Elongation	ASTM D 5035	51	percent
Tensile Strength	ASTM D 5034		89 lbs
Elongation	ASTM D 5034	21	percent
UV Stability*	ASTM D 4355		81* lbs
		90*	percent

NOTE 1: *ASTM D 5034 Tensile Strength and percent Strength Retention of material after 1000 hours of exposure in Xenon-Arc Weatherometer.

NOTE 2: Photodegradable life a minimum of 36 months with a minimum 90 percent light penetration. Apply to slopes up to a maximum 1:1 gradient.

2.4.11 Erosion Control Blankets Type XI (Re-vegetation Mat)

Seed-incorporated blanket option shall consist of 2-ply 100 percent recycled, unbleached, cellulose tissue. Uniformly distribute a seed mix upon the bottom ply of cellulose tissue and fully overlaid with a top cellulose ply to provide complete envelopment of the seed layer. Sew the seed-incorporated cellulose medium to the bottom side of the specified erosion control blanket.

Material Content

Top ply 1-ply 100 percent recycled unbleached cellulose tissue with approximately 4.3 lbs/1,000 ft² weight.

Seed 0.033 lbs/yd² (160 lbs/acre)

0.017 lbs/yd² (80 lbs/acre)

Bottom ply 1-ply recycled unbleached cellulose issue with approximately 4.3 lbs/(1,000 ft²) weight.

NOTE: Photodegradable life a minimum of 36 months with a minimum 90 percent light penetration. Apply to slopes up to a minimum 1:1 gradient.

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2.4.12 Erosion Control Blankets Type XII (Compost Mat)

Compost blanket shall consist of a layer of 100 percent biobased stable and mature compost uniformly distributed to a depth of 3/4 to 3 inches along slopes with erosion potential. Compost shall encourage plant growth and seed shall be applied following compost application. The blanket shall have the following properties:

Parameter	Range
Particle size	3/8-1/2 inch sieve and 2-3 inch sieve (ratio = 3:1)
Moisture content	20% - 50%
Soluble salt	3.0 - 6.0 mmhos/cm
Organic matter	40% - 70%
pH	6.0 - 8.0
Nitrogen content	0.5% - 2.0%
Human made inerts	0.0% - 1.0%

2.4.13 Seed

2.4.13.1 Seed Classification

2.4.13.2 Quality

Weed seed shall be a maximum 1 percent by weight of the total mixture.

2.4.14 Staking

Stakes shall be 100 percent biodegradable manufactured from recycled plastic or wood and shall be designed to safely and effectively secure erosion control blankets for temporary or permanent applications. The biodegradable stake shall be fully degradable by biological activity within a reasonable time frame. The bio-plastic resin used in production of the biodegradable stake shall consist of polylactide, a natural, completely biodegradable substance derived from renewable agricultural resources. The biodegradable stake must exhibit ample rigidity to enable being driven into hard ground, with sufficient flexibility to resist shattering. Serrate the biodegradable stake on the leg to increase resistance to pull-out from the soil.

2.4.15 Staples

Staples shall be as recommended by the manufacturer.

2.5 SYNTHETIC GRID AND SHEET SYSTEMS

Synthetic grid and sheet systems shall be formed of recycled plastic in accordance with paragraph RECYCLED PLASTICS and have interlocking components to form a uniform underlayment or strata to receive fill.

2.5.1 Synthetic Grid Systems

Grids shall be made of modular interlocking components. Form blocks as rigid interlocking components or as expandable sheets and manufacture to allow articulation upward and downward while restricting lateral movement. The assembled grid system shall articulate over three-directional vertical curves, both upward and downward. Provide 100 percent coverage of the area with the cells back filled.

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2.6 SEDIMENT FENCING

Wood or burlap.

2.7 COMPOST FILTER BERMS

Compost berms shall consist of 100 percent biobased trapezoidal-shaped compost piles arranged across slopes. Berms shall have the following properties:

Parameter	Range
Particle size	3/8-1/2 inch sieve and 2-3 inch sieve (ratio = 1:1)
Moisture content	20% - 50%
Soluble salt	4.0 - 6.0 mmhos/cm
Organic matter	40% - 70%
pH	6.0 - 8.0
Nitrogen content	0.5% - 2.0%
Human made inerts	0.0% - 1.0%
Size	1 - 2 feet H x 2.5 - 4 feet W

2.8 WATER

Unless otherwise directed, water is the responsibility of the Contractor. Water shall be potable or supplied by an existing irrigation system.

PART 3 EXECUTION

3.1 CONDITIONS

Perform erosion control operations under favorable weather conditions; when excessive moisture, frozen ground or other unsatisfactory conditions prevail, the work shall be stopped as directed. When special conditions warrant a variance to earthwork operations, submit a revised construction schedule for approval. Do not apply erosion control materials in adverse weather conditions which could affect their performance.

3.1.1 Finished Grade

Verify that finished grades are as indicated on the drawings prior to the commencement of the work. Verify and mark the location of underground utilities and facilities in the area of the work. Repair damage to underground utilities and facilities at the Contractor's expense.

3.1.2 Placement of Erosion Control Blankets

Before placing the erosion control blankets, ensure the subgrade has been graded smooth; has no depressed, void areas; is free from obstructions, such as tree roots, projecting stones or other foreign matter. Verify that mesh does not include invasive species. Vehicles shall not be permitted directly on the blankets.

3.1.3 Synthetic Grid

Before placing the grid system, ensure that the subgrade has been properly grubbed of large roots and rocks; compacted; has been graded smooth; has no depressed, void, soft or uncompacted areas; is free from obstructions, such as tree roots, projecting stones or other foreign matter; and has been seeded.

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3.1.4 Concrete Cellular Block

Before placing geotextile fabric under cellular block, ensure that the subgrade has been properly compacted; has been graded smooth; has no depressed, void, soft or uncompacted areas; is free from obstructions, such as tree roots, projecting stones or other foreign matter; and has been seeded. Compact subgrade compaction to at least 90 percent of the maximum dry density at optimum moisture content, as determined by ASTM D 698, with a tolerance of plus or minus 1 inch of the design elevation.

3.2 SITE PREPARATION

3.2.1 Soil Test

Test soil in accordance with ASTM D 5268 and ASTM D 4972 for determining the particle size and mechanical analysis. Sample collection onsite shall be random over the entire site. The test shall determine the soil particle size as compatible for the specified material.

3.2.2 Layout

Erosion control material locations may be adjusted to meet field conditions. When soil tests result in unacceptable particle sizes, a shop drawing shall be submitted indicating the corrective measures.

3.2.3 Protecting Existing Vegetation

When there are established lawns in the work area, the turf shall be covered and/or protected or replaced after construction operations. Identify existing trees, shrubs, plant beds, and landscape features that are to be preserved on site by appropriate tags and barricade with reusable, high-visibility fencing along the dripline. Mitigate damage to existing trees at no additional cost to the Government. Damage shall be assessed by a state certified arborist or other approved professional using the National Arborist Association's tree valuation guideline.

3.2.4 Obstructions Below Ground

When obstructions below ground affect the work, submit shop drawings showing proposed adjustments to placement of erosion control material for approval.

3.3 INSTALLATION

Immediately stabilize exposed soil using mulch, and seed. Stabilize areas for construction access immediately as specified in the paragraph Construction Entrance. Install principal sediment basins and traps before any major site grading takes place. Provide additional sediment traps and sediment fences as grading progresses. Provide inlet and outlet protection at the ends of new drainage systems. Remove temporary erosion control measures at the end of construction and provide permanent seeding.

3.3.1 Construction Entrance

Provide as indicated on drawings, a minimum of 6 inches thick, at points of vehicular ingress and egress on the construction site. Construction entrances shall be cleared and grubbed, and then excavated a minimum of 3 inches prior to placement of the filter fabric and aggregate. The

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aggregate shall be placed in a manner that will prevent damage and movement of the fabric. Place fabric in one piece, where possible. Overlap fabric joints a minimum of 12 inches.

3.3.2 Synthetic Binders

Apply synthetic binders heaviest at edges of areas and at crests of ridges and banks to prevent displacement.

3.3.3 Seeding

When seeding is required prior to installing mulch on synthetic grid systems verify that seeding will be completed in accordance with Section 32 92 99.98 TURF AND GRASSES.

3.3.4 Mulch Installation

install mulch in the areas indicated.

3.3.5 Mulch Control Netting

Netting may be stapled over mulch according to manufacturer's recommendations.

3.3.6 Mechanical Anchor

Mechanical anchor shall be a V-type-wheel land packer; a scalloped-disk land packer designed to force mulch into the soil surface; or other suitable equipment.

3.3.7 Asphalt Adhesive Tackifier

Asphalt adhesive tackifier shall be sprayed at a rate between 10 to 13 gallons/1000 square feet. Do not completely exclude sunlight from penetrating to the ground surface.

3.3.8 Non-Asphaltic Tackifier

Apply hydrophilic colloid at the rate recommended by the manufacturer, using hydraulic equipment suitable for thoroughly mixing with water. Apply a uniform mixture over the area.

3.3.9 Asphalt Adhesive Coated Mulch

Hay or straw mulch may be spread simultaneously with asphalt adhesive applied at a rate between 10 to 13 gallons/1000 square feet, using power mulch equipment equipped with suitable asphalt pump and nozzle. Apply the adhesive-coated mulch evenly over the surface. Do not completely exclude sunlight from penetrating to the ground surface.

3.3.10 Wood Cellulose Fiber, Paper Fiber, and Recycled Paper

Apply wood cellulose fiber, paper fiber, or recycled paper as part of the hydraulic mulch operation.

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3.3.11 Hydraulic Mulch Application

3.3.11.1 Unseeded Area

Install hydraulic mulch as indicated and in accordance with manufacturer's recommendations. Mix hydraulic mulch with water at the rate recommended by the manufacturer for the area to be covered. Mixing shall be done in equipment manufactured specifically for hydraulic mulching work, including an agitator in the mixing tank to keep the mulch evenly disbursed.

3.3.11.2 Seeded Area

For drill or broadcast seeded areas, apply hydraulic mulch evenly at the rate of .7 lbs. per square yard. For hydraulic seeded areas, apply mulch at the rate of .5 lbs. per square yard with the seed and fertilizer, and at the rate of .3 lbs. per square yard in a second application of mulch only.

3.3.12 Erosion Control Blankets

- a. Install erosion control blankets as indicated and in accordance with manufacturer's recommendations. The extent of erosion control blankets shall be as shown on drawings.
- b. Orient erosion control blankets in vertical strips and anchored with staples, as indicated. Abut adjacent strips to allow for installation of a common row of staples. Overlap horizontal joints between erosion control blankets sufficiently to accommodate a common row of staples with the uphill end on top.
- c. Where exposed to overland sheet flow, locate a trench at the uphill termination. Staple the erosion control blanket to the bottom of the trench. Backfill and compact the trench as required.
- d. Where terminating in a channel containing an installed blanket, the erosion control blanket shall overlap installed blanket sufficiently to accommodate a common row of staples.

3.3.13 Synthetic Sheet System

Anchor synthetic sheet systems in accordance with the manufacturer's recommendation. Place systems on a well graded surface and then backfill, a maximum seven days after placement, to protect the material from ultraviolet radiation. Include contiguous perimeter termination trenches as the installation progresses.

3.3.13.1 Sheet System Revegetation

For areas not requiring re-vegetation, backfill openings to grade with well graded fill material and surface prepared for finish as indicated on the drawings. For areas requiring re-vegetation, backfill openings using well graded fill and topsoil as indicated on the drawings.

3.3.13.2 Sheet System Grids

Each pair of grids shall cover grade without gaps or open spaces between them. Provide 100 percent coverage of the area with the cells backfilled.

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3.3.13.3 Sheet System Seeding

Install seed in accordance with Section 32 92 00.98 TURF AND GRASSES.

3.3.13.4 Grid System Grids

Anchor synthetic grid systems in accordance with the manufacturer's recommendation. Place interlocking grid systems on well graded surface. Complete the backfilling of openings a maximum 7 days after placement to protect the material from ultraviolet radiation. As the installation progresses, backfilling shall include contiguous perimeter termination trenches.

3.3.14 Grids

3.3.14.1 Grid System Revegetation

For areas not requiring re-vegetation, backfill openings with a minimum 1/2 inch nominal size crushed rock, to a minimum 2 inch depth.

3.3.14.2 Synthetic Grids

Each pair of grids shall cover grade without gaps or open spaces between them. The system shall provide 100 percent coverage of the area with the cells backfilled.

3.3.13.3 Grid System Seeding

Install seed in accordance with Section 32 92 00.98 TURF AND GRASSES.

3.3.15 Articulating Cellular Concrete Block System Installation

Underlay block installation with geotextile fabric in accordance with the manufacturer's recommendation. Begin block installation from a straight-line oriented perpendicular to the direction of lay, and proceed toward an open area and not toward a point of fixity. Install blocks with the bottom side down. Continue to lay blocks in straight-lines to maintain the interlock characteristic. To maintain straight-lines, no more than two rows of blocks shall be started at a time. The extent of blocks shall include the perimeter termination trenches and shall be as shown on the drawings. For installation purposes, the bottom of the block is the side with a flat unformed surface.

3.3.15.1 Concrete Grout

When abutting structures, such as culverts, piers and bridge abutments, furnish and install concrete grout full-depth in the void between the blocks and penetrations. Install grout as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.3.15.2 Toe Protection

Where exposed to hydraulic forces, the perimeter of the block system shall be turned into and buried beneath the adjacent ground level to a minimum 12 inch depth or as directed. Where not exposed to hydraulic forces, place the perimeter of the geotextile in a minimum 12 inch deep trench with the blocks flush with the adjacent surface. Excavate trenches as required for perimeter termination.

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3.3.15.3 Backfilling Cellular Block System

Complete backfilling of openings between blocks a maximum of 7 days after placement of the filter, to protect the geotextile from ultraviolet radiation. As the installation progresses, backfilling shall include contiguous perimeter termination trenches.

3.3.15.4 Block System Revegetation

For areas not requiring revegetation, backfill openings with a minimum 1/4 inch nominal size crushed rock to a minimum 2 inch depth or as otherwise specified, regardless of block thickness. For areas requiring revegetation as indicated, backfill openings with topsoil as specified.

3.3.15.5 Seeding, Fertilizing, Mulching

Install seed in accordance with Section 32 92 00.98 TURF AND GRASSES.

3.3.16 Sediment Fencing

Install posts at the spacing indicated on drawings and at an angle between 2 degrees and 20 degrees towards the potential silt load area. Sediment fence height shall be approximately 16 inches. Do not attach filter fabric to existing trees. Secure filter fabric to the post and wire fabric using staples, tie wire, or hog rings. Imbed the filter fabric into the ground as indicated on drawings. Splice filter fabric at support pole using a 6 inches overlap and securely seal.

3.4 CLEAN-UP

Dispose of excess material, debris, and waste materials offsite at an approved landfill or recycling center. Clear adjacent paved areas. Immediately upon completion of the installation in an area, protect the area against traffic or other use by erecting barricades and providing signage as required, or as directed.

3.5 WATERING SEED

Start watering immediately after installing erosion control blanket type XI (revegetation mat). Apply water to supplement rainfall at a sufficient rate to ensure moist soil conditions to a minimum 1 inch depth. Prevent run-off and puddling. Do no drive watering trucks over turf areas, unless otherwise directed. Prevent watering of other adjacent areas or plant material.

3.6 MAINTENANCE RECORD

Furnish a record describing the maintenance work performed, record of measurements and findings for product failure, recommendations for repair, and products replaced.

3.6.1 Maintenance

Maintenance shall include eradicating weeds; protecting embankments and ditches from surface erosion; maintaining the performance of the erosion control materials and mulch; protecting installed areas from traffic.

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3.6.2 Maintenance Instructions

Furnish written instructions containing drawings and other necessary information, describing the care of the installed material; including, when and where maintenance should occur, and the procedures for material replacement.

3.6.3 Patching and Replacement

Unless otherwise directed, material shall be placed, seamed or patched as recommended by the manufacturer. Remove material not meeting the required performance as a result of placement, seaming or patching from the site. Replace the unacceptable material at no additional cost to the Government.

3.7 SATISFACTORY STAND OF GRASS PLANTS

When erosion control blanket type XI (revegetation mat) is installed, evaluate the grass plants for species and health when the grass plants are a minimum 1 inch high. A satisfactory stand of grass plants from the revegetation mat area shall be a minimum 10 grass plants per square foot. The total bare spots shall not exceed 2 percent of the total revegetation mat area.

-- End of Section --

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SECTION 32 11 16

BASE COURSE FOR RIGID AND SUBBASES FOR FLEXIBLE PAVING 04/06

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO T 180 (2001; R 2004) Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and an 457-mm (18-in) Drop

AASHTO T 224 (2001; R 2004) Correction for Coarse Particles in the Soil Compaction Test

ASTM INTERNATIONAL (ASTM)

ASTM C 117 (2004) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing

ASTM C 131 (2006) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine

ASTM C 136 (2006) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates

ASTM C 29/C 29M (2007) Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate

ASTM D 1556 (2000) Density and Unit Weight of Soil in Place by the Sand-Cone Method

ASTM D 1557 (2002e1) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³) (2700 kN-m/m³)

ASTM D 2167 (1994; R 2001) Density and Unit Weight of Soil in Place by the Rubber Balloon Method

ASTM D 2487 (2006) Soils for Engineering Purposes (Unified Soil Classification System)

ASTM D 422 (1963; R 2002e1) Particle-Size Analysis of Soils

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ASTM D 4318	(2005) Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D 6938	(2007a) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
ASTM D 75	(2003) Standard Practice for Sampling Aggregates
ASTM E 11	(2004) Wire Cloth and Sieves for Testing Purposes

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01 33 00
SUBMITTAL PROCEDURES:

SD-03 Product Data

Equipment

List of proposed equipment to be used in performance of construction work, including descriptive data.

Waybills and Delivery Tickets

Copies of waybills and delivery tickets during the progress of the work.

SD-06 Test Reports

Sampling and Testing

Field Density Tests

Certified copies of test results for approval not less than 7 days before material is required for the work.

Calibration curves and related test results prior to using the device or equipment being calibrated.

Copies of field test results within 24 hours after the tests are performed.

1.3 UNIT PRICES

1.3.1 Measurment

1.3.1.1 Area

The quantity of subbase and rigid pavement base course completed and accepted as determined by the Contracting Officer shall be measured in square yards.

1.3.1.2 Volume

The quantity of subbase and rigid pavement base course completed and

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accepted as determined by the Contracting Officer shall be measured in cubic yards. The volume of material in-place and accepted shall be determined by the average job thickness obtained in accordance with paragraph THICKNESS CONTROL and the dimensions shown.

1.3.1.3 Weight

The tonnage of subbase and rigid pavement base course material shall be the number of tons of aggregate, placed and accepted in the completed course as determined by the Contracting Officer. Deductions will be made for any material wasted, unused, rejected, or used for convenience of the Contractor, and for water exceeding specified amount at time of weighing.

1.3.2 Payment

1.3.2.1 Course Material

Quantities of subbase and rigid pavement base course, determined as specified in paragraph Measurement, will be paid for at the respective contract unit prices, which shall constitute full compensation for the construction and completion of the subbase and rigid pavement base course.

1.3.2.2 Stabilization

Cohesionless subgrades or select subbase courses to be stabilized, as specified in paragraph PREPARATION OF UNDERLYING MATERIAL, will be paid as a special item on the tonnage basis including extra manipulation as required.

1.3.3 Waybills and Delivery Tickets

Copies of waybills and delivery tickets shall be submitted during the progress of the work.

1.4 DEGREE OF COMPACTION

Degree of compaction required, except as noted in the second sentence, is expressed as a percentage of the maximum laboratory dry density obtained by the test procedure presented in ASTM D 1557 abbreviated as a percent of laboratory maximum dry density. Since ASTM D 1557 applies only to soils that have 30 percent or less by weight of their particles retained on the 3/4 inch sieve, the degree of compaction for material having more than 30 percent by weight of their particles retained on the 3/4 inch sieve shall be expressed as a percentage of the laboratory maximum dry density in accordance with AASHTO T 180 Method D and corrected with AASHTO T 224.

1.5 SAMPLING AND TESTING

Tests shall be performed at the specified frequency. No work requiring testing will be permitted until the testing laboratory has been inspected and approved. The materials shall be tested to establish compliance with the specified requirements.

1.5.1 Sampling

Samples for laboratory testing shall be taken in conformance with ASTM D 75. When deemed necessary, the sampling will be observed by the Contracting Officer.

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1.5.2 Tests

1.5.2.1 Sieve Analysis

Sieve analysis shall be made in conformance with [ASTM C 117](#) and [ASTM C 136](#). Sieves shall conform to [ASTM E 11](#).

1.5.2.2 Liquid Limit and Plasticity Index

Liquid limit and plasticity index shall be determined in accordance with [ASTM D 4318](#).

1.5.2.3 Moisture-Density Determinations

The laboratory maximum dry density and optimum moisture shall be determined in accordance with [ASTM D 1557](#).

1.5.2.4 Field Density Tests

Density shall be field measured in accordance with [ASTM D 1556](#), [ASTM D 2167](#), or [ASTM D 6938](#). For the method presented in [ASTM D 1556](#), the base plate, as shown in the drawing, shall be used. For the method presented in [ASTM D 6938](#), the calibration curves shall be checked and adjusted, if necessary, using only the sand cone method as described in paragraph Calibration, of the ASTM publication. Tests performed in accordance with [ASTM D 6938](#) result in a wet unit weight of soil and [ASTM D 6938](#) shall be used to determine the moisture content of the soil. The calibration curves furnished with the moisture gauges shall also be checked along with density calibration checks as described in [ASTM D 6938](#). The calibration checks of both the density and moisture gauges shall be made by the prepared containers of material method, as described in paragraph Calibration, in [ASTM D 6938](#), on each different type of material to be tested at the beginning of a job and at intervals as directed.

1.5.2.5 Wear Test

Wear tests shall be made in conformance with [ASTM C 131](#).

1.5.2.6 Weight of Slag

Weight per cubic foot of slag shall be determined in accordance with [ASTM C 29/C 29M](#).

1.5.3 Testing Frequency

1.5.3.1 Initial Tests

One of each of the following tests shall be performed on the proposed material prior to commencing construction to demonstrate that the proposed material meets all specified requirements prior to installation.

- a. Sieve Analysis including 0.02 mm size material
- b. Liquid limit and plasticity index
- c. Moisture-density relationship
- d. Wear

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1.5.3.2 In-Place Tests

One of each of the following tests shall be performed on samples taken from the placed and compacted subbase and rigid pavement base course. Samples shall be taken and tested at the rates indicated.

- a. Density tests shall be performed on every lift of material placed and at a frequency of one set of tests for every 500 square yards, or portion thereof, of completed area.
- b. Sieve Analysis shall be performed on every lift of material placed and at a frequency of one sieve analysis for every 1000 square yards, or portion thereof, of material placed.
- c. Liquid limit and plasticity index tests shall be performed at the same frequency as the sieve analysis.
- d. The thickness of each course shall be measured at intervals providing at least one measurement for each 500 square yards or part thereof. The thickness measurement shall be made by test holes, at least 3 inches in diameter through the course.

1.5.4 Approval of Material

The source of the material shall be selected 30 days prior to the time the material will be required in the work. Tentative approval will be based on initial test results. Final approval of the materials will be based on tests for gradation, liquid limit, and plasticity index performed on samples taken from the completed and compacted course.

1.6 WEATHER LIMITATIONS

Construction shall be done when the atmospheric temperature is above 35 degrees F. When the temperature falls below 35 degrees F, the Contractor shall protect all completed areas by approved methods against detrimental effects of freezing. Completed areas damaged by freezing, rainfall, or other weather conditions shall be corrected to meet specified requirements.

1.7 EQUIPMENT

All plant, equipment, and tools used in the performance of the work will be subject to approval before the work is started and shall be maintained in satisfactory working condition at all times. The equipment shall be adequate and shall have the capability of producing the required compaction, meeting grade controls, thickness control, and smoothness requirements as set forth herein.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Subbase Course

Aggregates shall consist of crushed stone or slag, gravel, shell, sand, or other sound, durable, approved materials processed and blended or naturally combined. Aggregates shall be durable and sound, free from lumps and balls of clay, organic matter, objectionable coatings, and other foreign material. Material retained on the No. 4 sieve shall have a percentage of wear not to exceed 50 percent after 500 revolutions when tested as

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specified in [ASTM C 131](#). Aggregate shall be reasonably uniform in density and quality. Slag shall be an air-cooled, blast-furnace product having a dry weight of not less than [65 pcf](#). Aggregates shall have a maximum size of [2 inches](#) and shall be within the limits specified as follows:

Maximum Allowable Percentage by Weight Passing Square-Mesh Sieve

Sieve Designation	No. 1	No.2	No. 3
No. 10	50	80	100
No. 200	8	8	8

Particles having diameters less than [0.0008 inches](#) shall not be in excess of 3 percent by weight of the total sample tested as determined in accordance with [ASTM D 422](#). The portion of any blended component and of the completed course passing the [No. 40 sieve](#) shall be either nonplastic or shall have a liquid limit not greater than 25 and a plasticity index not greater than 5.

2.1.1.2 Rigid Pavement Base Course

Aggregates shall consist of crushed stone or slag, gravel, shell, sand, or other sound, durable, approved materials processed and blended or naturally combined. Aggregates shall be durable and sound, free from lumps and balls of clay, organic matter, objectionable coatings, and other foreign material. Material retained on the [No. 4](#) sieve shall have a percentage of wear not to exceed 50 percent after 500 revolutions when tested as specified in [ASTM C 131](#). At least 50 percent by weight retained on each sieve shall have one freshly fractured face with the area at least equal to 75 percent of the smallest midsectional area of the piece. Aggregate shall be reasonably uniform in density and quality. Slag shall be an air-cooled, blast-furnace product having a dry weight of not less than [65 pcf](#). Aggregates shall have a maximum size of [2 inches](#) and shall be within the limits specified as follows:

Maximum Allowable Percentage by Weight Passing Square-Mesh Sieve

Sieve Designation	Rigid Pavement Base Course
No. 10	85
No. 200	8

The portion of any blended component and of the completed course passing the [No. 40 sieve](#) shall be either nonplastic or shall have a liquid limit not greater than 25 and a plasticity index not greater than 8. The Contractor shall be responsible for any additional stability required to provide a working platform for construction equipment. If the Contractor can demonstrate with a test section that a material has adequate stability to support construction equipment, the fractured face requirement can be deleted, subject to the approval of the Contracting Officer.

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PART 3 EXECUTION

3.1 OPERATION OF AGGREGATE SOURCES

Clearing, stripping and excavating shall be the responsibility of the Contractor. The aggregate sources shall be operated to produce the quantity and quality of materials meeting these specifications requirements in the specified time limit. Upon completion of work, aggregate sources on Government property shall be conditioned to drain readily, and shall be left in a satisfactory condition. Aggregate sources on private lands shall be conditioned in agreement with local laws and authorities.

3.2 STOCKPILING MATERIAL

Prior to stockpiling of material, storage sites shall be cleared and leveled by the Contractor. All materials, including approved material available from excavation and grading, shall be stockpiled in the manner and at the locations designated. Aggregates shall be stockpiled on the cleared and leveled areas designated by the Contracting Officer to prevent segregation. Materials obtained from different sources shall be stockpiled separately.

3.3 PREPARATION OF UNDERLYING MATERIAL

Prior to constructing the subbase rigid pavement base course, the underlying course or subgrade shall be cleaned of all foreign substances. The surface of the underlying course or subgrade shall meet specified compaction and surface tolerances. Ruts, or soft yielding spots, in the underlying courses, subgrade areas having inadequate compaction, and deviations of the surface from the specified requirements, shall be corrected by loosening and removing soft or unsatisfactory material and by adding approved material, reshaping to line and grade, and recompacting to specified density requirements. For cohesionless underlying courses or subgrades containing sands or gravels, as defined in [ASTM D 2487](#), the surface shall be stabilized prior to placement of the overlying course. Stabilization shall be accomplished by mixing the overlying course material into the underlying course, and compacting by approved methods. The stabilized material shall be considered as part of the underlying course and shall meet all requirements for the underlying course. The finished underlying course shall not be disturbed by traffic or other operations and shall be maintained by the Contractor in a satisfactory condition until the overlying course is placed.

3.4 GRADE CONTROL

The finished and completed course shall conform to the lines, grades, and cross sections shown. The lines, grades, and cross sections shown shall be maintained by means of line and grade stakes placed by the Contractor at the work site.

3.5 MIXING AND PLACING MATERIALS

The materials shall be mixed and placed to obtain uniformity of the material at the water content specified. The Contractor shall make such adjustments in mixing or placing procedures or in equipment as may be directed to obtain the true grades, to minimize segregation and degradation, to reduce or accelerate loss or increase of water, and to insure a satisfactory subbase course.

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3.6 LAYER THICKNESS

The compacted thickness of the completed course shall be as indicated. When a compacted layer of 6 inches is specified, the material may be placed in a single layer; when a compacted thickness of more than 6 inches is required, no layer shall be thicker than 6 inches nor be thinner than 3 inches when compacted.

3.7 COMPACTION

Each layer of the material shall be compacted as specified with approved compaction equipment. Water content shall be maintained during the compaction procedure to within plus or minus 2 percent of optimum water content, as determined from laboratory tests, as specified in paragraph SAMPLING AND TESTING. In all places not accessible to the rollers, the mixture shall be compacted with hand-operated power tampers. Compaction of the subbase shall continue until each layer is compacted through the full depth to at least 100 percent of laboratory maximum density. Compaction of the rigid base course shall continue until each layer is compacted through the full depth to at least 98 percent of laboratory maximum density. The Contractor shall make such adjustments in compacting or finishing procedures as may be directed to obtain true grades, to minimize segregation and degradation, to reduce or increase water content, and to ensure a satisfactory subbase course. Any materials that are found to be unsatisfactory shall be removed and replaced with satisfactory material or reworked, as directed, to meet the requirements of this specification.

3.8 EDGES

Approved material shall be placed along the edges of the subbase course in such quantity as will compact to the thickness of the course being constructed. When the course is being constructed in two or more layers, at least a 1 foot width of the shoulder shall be rolled and compacted simultaneously with the rolling and compacting of each layer of the subbase course, as directed.

3.9 SMOOTHNESS TEST

The surface of the top layer shall show no deviations in excess of 3/8 inch when tested with a 12 foot straightedge. Measurements shall be taken in successive positions parallel to the centerline of the area to be paved. Measurements shall also be taken perpendicular to the centerline at 50 foot intervals. Deviations exceeding this amount shall be corrected by removing material and replacing with new material, or by reworking existing material and compacting it to meet these specifications.

3.10 THICKNESS CONTROL

The completed thickness of the course(s) shall be in accordance with the thickness and grade indicated on the drawings. The completed course shall not be more than 1/2 inch deficient in thickness nor more than 1/2 inch above or below the established grade. Where any of these tolerances are exceeded, the Contractor shall correct such areas by scarifying, adding new material of proper gradation or removing material, and compacting, as directed. Where the measured thickness is 1/2 inch or more thicker than shown, the course will be considered as conforming with the specified thickness requirements plus 1/2 inch. The average job thickness shall be the average of the job measurements as specified above but within 1/4 inch of the thickness shown.

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00252

3.11 MAINTENANCE

The completed course shall be maintained in a satisfactory condition until accepted.

-- End of Section --

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BITUMINOUS TACK AND PRIME COATS 10/06

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS
(AASHTO)

AASHTO M 82 (1975; R 2004) Cut-Back Asphalt
(Medium-Curing Type)

AASHTO T 102 (1983; R 2004) Spot Test of Asphaltic
Materials

ASTM INTERNATIONAL (ASTM)

ASTM D 2027 (1997; R 2004) Cutback Asphalt
(Medium-Curing Type)

ASTM D 2028 (1997; R 2004) Cutback Asphalt
(Rapid-Curing Type)

ASTM D 977 (2005) Emulsified Asphalt

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01 33 00
SUBMITTAL PROCEDURES:

SD-03 Product Data

Waybills and Delivery Tickets

Waybills and delivery tickets, during progress of the work.

SD-06 Test Reports

Sampling and Testing

Copies of all test results for emulsified asphalt, and bituminous materials, within 24 hours of completion of tests. Certified copies of the manufacturer's test reports indicating temperature viscosity relationship for cutback asphalt, compliance with applicable specified requirements, not less than 30 days before the material is required in the work.

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1.3 UNIT PRICES

1.3.1 Measurement

The bituminous material paid for will be the measured quantities used in the accepted work, provided that the measured quantities are not 10 percent over the specified application rate. Any amount of bituminous material more than 10 percent over the specified application rate for each application shall be deducted from the measured quantities, except for irregular areas where hand spraying of the bituminous material is necessary. Measured quantities shall be expressed in 2000 pound tons.

1.3.2 Payment

The quantities of bituminous material, determined as specified above, will be paid for at the respective contract unit prices. Payment shall constitute full compensation for all operations necessary to complete the work as specified herein.

1.3.3 Waybills and Delivery Tickets

Before the final statement is allowed, the Contractor shall file with the Contracting Officer certified waybills and certified delivery tickets for all bituminous materials used in the construction of the pavement covered by the contract. These submittals are required for Unit Pricing bid only. The Contractor shall not remove bituminous material from storage until the initial outage and temperature measurements have been taken. The delivery or storage units will not be released until the final outage has been taken.

1.4 PLANT, EQUIPMENT, MACHINES AND TOOLS

1.4.1 General Requirements

Plant, equipment, machines and tools used in the work are subject to approval and must be maintained in a satisfactory working condition at all times. Calibrated equipment such as asphalt distributors, scales, batching equipment, spreaders and similar equipment, shall have been recalibrated by a calibration laboratory within 12 months prior to commencing work.

1.4.2 Bituminous Distributor

The distributor shall have pneumatic tires of such size and number that the load produced on the base surface does not exceed 650 psi of tire width and to prevent rutting, shoving or otherwise damaging the base surface or other layers in the pavement structure. Design and equip the distributor to spray the bituminous material in a uniform coverage at the specified temperature, at readily determined and controlled rates from 0.05 to 2.0 gallons per square yard, with a pressure range of 25 to 75 psi and with an allowable variation from the specified rate of not more than plus or minus 5 percent, and at variable widths. Distributor equipment shall include a separate power unit for the bitumen pump, full-circulation spray bars, tachometer, pressure gauges, volume-measuring devices, adequate heaters for heating of materials to the proper application temperature, a thermometer for reading the temperature of tank contents, and a hand hose attachment suitable for applying bituminous material manually to areas inaccessible to the distributor. Equip the distributor to circulate and agitate the bituminous material during the heating process.

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1.4.3 Heating Equipment for Storage Tanks

The equipment for heating the bituminous material shall be steam, electric, or hot oil heaters. Steam heaters shall consist of steam coils and equipment for producing steam, so designed that the steam cannot get into the material. Fix an armored thermometer to the tank with a temperature range from 40 to 400 degrees F so that the temperature of the bituminous material may be determined at all times.

1.4.4 Power Brooms and Power Blowers

Use power brooms and power blowers suitable for cleaning the surfaces to which the bituminous coat is to be applied.

1.5 WEATHER LIMITATIONS

Apply bituminous coat only when the surface to receive the bituminous coat is dry. Apply bituminous coat only when the atmospheric temperature in the shade is 50 degrees F or above and when the temperature has not been below 35 degrees F for the 12 hours prior to application, unless otherwise directed.

1.6 DELIVERY AND STORAGE

Inspect the materials delivered to the site for contamination and damage. Unload and store the materials with a minimum of handling.

PART 2 PRODUCTS

2.1 PRIME COAT

Asphalt shall conform to AASHTO M 82, Grade MC-70 and specified in the following two subparagraphs.

2.1.1 Cutback Asphalt

Cutback asphalt shall conform to ASTM D 2027, Grade MC-70.

2.1.2 Emulsified Asphalt

Emulsified asphalt shall conform to ASTM D 977, Type SS-1.

2.2 TACK COAT

Asphalt shall conform to ASTM D 2028 Grade MC-70.

2.2.1 Cutback Asphalt

Cutback asphalt shall conform to ASTM D 2027, Grade MC-70.

2.2.2 Emulsified Asphalt

Emulsified asphalt shall conform to ASTM D 977, Type SS-1. Dilute the emulsified asphalt with equal parts of water. The base asphalt used to manufacture the emulsion shall show a negative spot when tested in accordance with AASHTO T 102 using standard naphtha.

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PART 3 EXECUTION

3.1 PREPARATION OF SURFACE

Immediately before applying the bituminous coat, remove all loose material, dirt, clay, or other objectionable material from the surface to be treated by means of a power broom or blower supplemented with hand brooms. The surface shall be dry and clean at the time of treatment.

3.2 APPLICATION RATE

Emulsified asphalt mixing grades such as SS-1, SS-1h, CSS-1, and CSS-1h perform best when diluted with equal parts of water and applied at the rate of 0.23-0.68 liter of diluted emulsion per square meter 0.05-0.15 gallon of diluted emulsion per square yard

3.2.1 Tack Coat

Apply bituminous material for the tack coat in quantities of not less than 0.05 gallon nor more than 0.15 gallon per square yard of pavement surface.

3.2.2 Prime Coat

Apply bituminous material for the prime coat in quantities of not less than 0.15 gallon nor more than 0.40 gallon per square yard of pavement surface.

3.3 APPLICATION TEMPERATURE

3.3.1 Viscosity Relationship

Asphalt application temperature shall provide an application viscosity between 10 and 60 seconds, Saybolt Furol, or between 20 and 120 centistokes, kinematic. Furnish the temperature viscosity relation to the Contracting Officer.

3.3.2 Temperature Ranges

The viscosity requirements determine the application temperature to be used. The following is a normal range of application temperatures:

Liquid Asphalts

Paving Grade Asphalts

Penetration Grades

120-150

plus 270 degrees F

Viscosity Grades

AC 5

plus 280 degrees F

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AR 2000

plus 285 degrees F

Emulsions

SS-1

70-160 degrees F

*These temperature ranges exceed the flash point of the material and care should be taken in their heating.

3.4 APPLICATION

3.4.1 General

Following preparation and subsequent inspection of the surface, apply the bituminous prime or tack coat with the Bituminous Distributor at the specified rate with uniform distribution over the surface to be treated. Properly treat all areas and spots missed by the distributor with the hand spray. Until the succeeding layer of pavement is placed, maintain the surface by protecting the surface against damage and by repairing deficient areas at no additional cost to the Government. If required, spread clean dry sand to effectively blot up any excess bituminous material. No smoking, fires, or flames other than those from the heaters that are a part of the equipment are permitted within 25 feet of heating, distributing, and transferring operations of bituminous material other than bituminous emulsions. Prevent all traffic, except for paving equipment used in constructing the surfacing, from using the underlying material, whether primed or not, until the surfacing is completed. The bituminous coat shall conform to all requirements as described herein.

3.4.2 Prime Coat

Apply as soon as possible after consolidation of the underlying material. Apply the bituminous material uniformly over the surface to be treated at a pressure range of 25 to 75 psi and at the rate of not less than 0.20 gallon not more than 0.30 gallon per square yard. To obtain uniform application of the prime coat on the surface treated at the junction of previous and subsequent applications, spread building paper on the surface for a sufficient distance back from the ends of each application to start and stop the prime coat on the paper and to ensure that all sprayers will operate at full force on the surface to be treated. Immediately after application remove and destroy the building paper.

3.4.3 Tack Coat

Apply tack coat at the locations shown on the drawings. Apply the tack coat when the surface to be treated is dry. Immediately following the preparation of the surface for treatment, apply the bituminous material by means of the bituminous distributor, within the limits of temperature specified herein and at a rate of not less than 0.05 gallon nor more than 0.15 gallon of diluted emulsion per square yard. Apply the bituminous material so that uniform distribution is obtained over the entire surface to be treated. Treat lightly coated areas and spots missed by the distributor with the bituminous material. Following the application of bituminous material, allow the surface to cure without being disturbed for period of time necessary to permit setting of the tack coat. Apply the bituminous tack coat only as far in advance of the placing of the overlying

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layer as required for that day's operation. Maintain and protect the treated surface from damage until the succeeding course of pavement is placed.

3.5 CURING PERIOD

Following application of the bituminous material and prior to application of the succeeding layer of pavement, the bituminous coat shall be allowed to cure and to obtain evaporation of any volatiles or moisture. Maintain the coated surface until the succeeding layer of pavement is placed, by protecting the surface against damage and by repairing and recoating deficient areas. Allow the prime coat to cure without being disturbed for a period of at least 48 hours or longer, as may be necessary to attain penetration into the treated course. Furnish and spread enough sand to effectively blot up and cure excess bituminous material.

3.6 SAMPLING AND TESTING

Sampling and testing shall be performed by an approved commercial testing laboratory or by facilities furnished by the Contractor. No work requiring testing will be permitted until the facilities have been inspected and approved.

3.6.1 Trial Applications

Before providing the complete bituminous coat, apply three lengths of at least 100 feet for the full width of the distributor bar to evaluate the amount of bituminous material that can be satisfactorily applied.

3.6.1.1 Tack Coat Trial Application Rate

Unless otherwise authorized, apply the trial application rate of bituminous tack coat materials in the amount of 0.05 gallons per square yard. Other trial applications shall be made using various amounts of material as may be deemed necessary.

3.6.1.2 Prime Coat Trial Application Rate

Unless otherwise authorized, apply the trial application rate of bituminous materials in the amount of 0.25 gallon per square yard. Other trial applications shall be made using various amounts of material as may be deemed necessary.

3.6.2 Sampling and Testing During Construction

Perform quality control sampling and testing as required in paragraph FIELD QUALITY CONTROL.

3.7 TRAFFIC CONTROLS

Keep traffic off surfaces freshly treated with bituminous material. Provide sufficient warning signs and barricades so that traffic will not travel over freshly treated surfaces.

-- End of Section --

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SECTION 32 12 17

HOT MIX BITUMINOUS PAVEMENT

04/08

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS
(AASHTO)

AASHTO MP 1a (2004) Performance Graded Asphalt Binder

ASPHALT INSTITUTE (AI)

AI MS-02 (6th Edition; 1997) Mix Design Methods for Asphalt

ASTM INTERNATIONAL (ASTM)

ASTM C 117 (2004) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing

ASTM C 127 (2007) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate

ASTM C 128 (2007a) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate

ASTM C 131 (2006) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine

ASTM C 136 (2006) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates

ASTM C 188 (1995; R 2003) Standard Test Method for Density of Hydraulic Cement

ASTM C 29/C 29M (2007) Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate

ASTM C 88 (2005) Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate

ASTM D 1073 (2007) Fine Aggregate for Bituminous Paving Mixtures

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ASTM D 1188	(2007) Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens
ASTM D 140	(2001; R 2007) Sampling Bituminous Materials
ASTM D 1559	(1989) Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus
ASTM D 2041	(2003a) Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures
ASTM D 2172	(2005) Quantitative Extraction of Bitumen from Bituminous Paving Mixtures
ASTM D 242	(2004) Mineral Filler for Bituminous Paving Mixtures
ASTM D 2726	(2005a) Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures
ASTM D 3381	(2005) Viscosity-Graded Asphalt Cement for Use in Pavement Construction
ASTM D 4867/D 4867M	(2004) Effect of Moisture on Asphalt Concrete Paving Mixtures
ASTM D 546	(2005) Sieve Analysis of Mineral Filler for Bituminous Paving Mixtures
ASTM D 692	(2000; R 2004) Coarse Aggregate for Bituminous Paving Mixtures
ASTM D 70	(2003) Specific Gravity and Density of Semi-Solid Bituminous Materials (Pycnometer Method)
ASTM D 75	(2003) Standard Practice for Sampling Aggregates
ASTM D 854	(2006e1) Specific Gravity of Soil Solids by Water Pycnometer
ASTM D 946	(1982; R 2005) Penetration-Graded Asphalt Cement for Use in Pavement Construction
ASTM D 979	(2001; R 2006e1) Sampling Bituminous Paving Mixtures
ASTM D 995	(1995b; R 2002) Mixing Plants for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures

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1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-05 Design Data

Job-mix formula

Submit a job-mix formula, prepared specifically for this project within one year of submittal for roads, for approval by the Government prior to preparing and placing the bituminous mixture. Design mix using procedures contained in Chapter V, Marshall Method of Mix Design, of AI MS-02. Formulas shall indicate physical properties of the mixes as shown by tests made by a commercial laboratory approved by the Contracting Officer, using materials identical to those to be provided on this project. Submit formulas with material samples. Job-mix formula for each mixture shall be in effect until modified in writing by the Contractor and approved by the Contracting Officer. Provide a new job-mix formula for each source change. Submittal shall include all tests indicated in MIX DESIGN section of this specification.

ASPHALT CEMENT BINDER

MIX DESIGN

SD-06 Test Reports

Specific gravity test of asphalt

Coarse aggregate tests

Weight of slag test

Percent of crushed pieces in gravel

Fine aggregate tests

Specific gravity of mineral filler

Bituminous mixture tests

Aggregates tests

Bituminous mix tests

Pavement courses

Submit in accordance with paragraph entitled "Mock-Up Test Section."

1.3 QUALITY ASSURANCE

1.3.1 Safety Requirements

Provide adequate and safe stairways with handrails to the mixer platform, and safe and protected ladders or other means for accessibility to plant operations. Guard equipment and exposed steam or other high temperature

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lines or cover with a suitable type of insulation.

1.3.2 Required Data

Job-mix formula shall show the following:

- a. Source and proportions, percent by weight, of each ingredient of the mixture;
- b. Correct gradation, the percentages passing each size sieve listed in the specifications for the mixture to be used, for the aggregate and mineral filler from each separate source and from each different size to be used in the mixture and for the composite mixture;
- c. Amount of material passing the No. 200 sieve determined by dry sieving;
- d. Number of blows of hammer compaction per side of molded specimen;
- e. Temperature viscosity relationship of the asphalt cement;
- f. Stability, flow, percent voids in mineral aggregate, percent air voids, unit weight;
- g. Asphalt absorption by the aggregate;
- h. Effective asphalt content as percent by weight of total mix;
- i. Temperature of the mixture immediately upon completion of mixing;
- j. Asphalt performance grade viscosity grade; and
- k. Curves for the wearing course.

1.3.3 Charts

Plot and submit, on a grain size chart, the specified aggregate gradation band, the job-mix gradation and the job-mix tolerance band.

1.3.4 Selection of Optimum Asphalt Content

Base selection on percent of total mix and the average of values at the following points on the curves for each mix:

- a. Stability: Peak
- b. Unit Weight: Peak
- c. Percent Air Voids: Median

1.4 DELIVERY, STORAGE, AND HANDLING

Inspect materials delivered to the site for damage and store with a minimum of handling. Store aggregates in such a manner as to prevent segregation, contamination, or intermixing of the different aggregate sizes.

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1.5 ENVIRONMENTAL CONDITIONS

Place bituminous mixture only during dry weather and on dry surfaces. Place courses only when the surface temperature of the underlying course is greater than 45 degrees F for course thicknesses greater than one inch and 55 degrees F for course thicknesses one inch or less.

1.6 CONSTRUCTION EQUIPMENT

Calibrated equipment, such as scales, batching equipment, spreaders and similar equipment, shall have been recalibrated by a calibration laboratory approved by the Contracting Officer within 12 months of commencing work.

1.6.1 Mixing Plant

Design, coordinate, and operate the mixing plant to produce a mixture within the job-mix formula tolerances and to meet the requirements of ASTM D 995, including additional plant requirements specified herein. The plant shall be a batch type, continuous mix type or drum-dryer mixer type, and shall have sufficient capacity to handle the new bituminous construction. Minimum plant capacity shall be 100 tons per hour. The mixing plant and equipment shall remain accessible at all times for inspecting operation, verifying weights, proportions and character of materials, and checking mixture temperatures.

1.6.1.1 Cold Aggregate Feeder

Provide plant with a feeder or feeders capable of delivering the maximum number of aggregate sizes required in their proper proportion. Provide adjustment for total and proportional feed and feeders capable of being locked in any position. When more than one cold elevator is used, feed each elevator as a separate unit and install individual controls integrated with a master control.

1.6.1.2 Dryer

Provide rotary drum-dryer which continuously agitates the mineral aggregate during the heating and drying process. When one dryer does not dry the aggregate to specified moisture requirements, provide additional dryers.

1.6.1.3 Plant Screens and Bins for Batch and Continuous Mix Plants

Use screen to obtain accurate gradation and allow no bin to contain more than 10 percent oversize or undersize. Inspect screens each day prior to commencing work for plugged, worn, or broken screens. Clean plugged screens and replace worn or broken screens with new screens prior to beginning operations. Divide hot aggregate bins into at least three compartments arranged to ensure separate and adequate storage of appropriate fractions of the aggregate.

1.6.1.4 Drum-Dryer Mixer

Do not use drum-dryer mixer if specified requirements of the bituminous mixture or of the completed bituminous pavement course cannot be met. If drum-dryer mixer is prohibited, use either batch or continuous mix plants meeting the specifications and producing a satisfactory mix.

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1.6.2 Paving Equipment

1.6.2.1 Spreading Equipment

Self-propelled electronically controlled type. Equip spreading equipment of the self-propelled electronically controlled type with hoppers, tamping or vibrating devices, distributing screws, electronically adjustable screeds, and equalizing devices. Capable of spreading hot bituminous mixtures without tearing, shoving, or gouging and to produce a finished surface of specified grade and smoothness. Operate spreaders, when laying mixture, at variable speeds between 5 and 45 feet per minute. Design spreader with a quick and efficient steering device; a forward and reverse traveling speed; and automatic devices to adjust to grade and confine the edges of the mixture to true lines. The use of a spreader that leaves indented areas or other objectionable irregularities in the fresh laid mix during operations is prohibited.

1.6.2.2 Rolling Equipment

Self-propelled pneumatic-tired rollers supplemented by three-wheel and tandem type steel wheel rollers. The number, type and weight of rollers shall be sufficient to compact the mixture to the required density without detrimentally affecting the compacted material. Rollers shall be suitable for rolling hot-mix bituminous pavements and capable of reversing without backlash. Pneumatic-tired rollers shall be capable of being operated both forward and backward without turning on the mat, and without loosening the surface being rolled. Equip rollers with suitable devices and apparatus to keep the rolling surfaces wet and prevent adherence of bituminous mixture. Vibratory rollers especially designed for bituminous concrete compaction may be used provided rollers do not impair stability of pavement structure and underlying layers. Repair depressions in pavement surfaces resulting from use of vibratory rollers. Rollers shall be self-propelled, single or dual vibrating drums, and steel drive wheels, as applicable; equipped with variable amplitude and separate controls for energy and propulsion.

1.6.2.3 Hand Tampers

Minimum weight of 25 pounds with a tamping face of not more than 50 square inches.

1.6.2.4 Mechanical Hand Tampers

Commercial type, operated by pneumatic pressure or by internal combustion.

PART 2 PRODUCTS

2.1 AGGREGATES

Grade and proportion aggregates and filler so that combined mineral aggregate conforms to specified grading.

2.1.1 Coarse Aggregates

ASTM D 692, except as modified herein. At least 75 percent by weight of aggregate retained on the No. 4 sieve shall have two or more fractured faces. Percentage of wear, Los Angeles test, except for slag, shall not exceed 40 in accordance with ASTM C 131. Weight of slag shall not be less than 70 pounds per cubic foot. Soundness test is required in accordance with ASTM C 88; after 5 cycles, loss shall not be more than 12 percent when

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tested with sodium sulfate or 18 percent when tested with magnesium sulfate.

2.1.2 Fine Aggregate

ASTM D 1073, except as modified herein. Fine aggregate shall be produced by crushing stone, slag or gravel that meets requirements for wear and soundness specified for coarse aggregate. Where necessary to obtain the gradation of aggregate blend or workability, natural sand may be used. Quantity of natural sand to be added shall be approved by the Contracting Officer and shall not exceed 10 percent of weight of coarse and fine aggregate and material passing the No. 200 sieve.

2.1.3 Mineral Filler

Nonplastic material meeting the requirements of ASTM D 242.

2.1.4 Aggregate Gradation

The combined aggregate gradation shall conform to gradations specified in Table I, when tested in accordance with ASTM C 136 and ASTM C 117, and shall not vary from the low limit on one sieve to the high limit on the adjacent sieve or vice versa, but grade uniformly from coarse to fine.

Table I. Aggregate Gradations

Gradation 1

Sieve Size, inch	Percent Passing by Mass
1	---
3/4	100
1/2	76-96
3/8	69-89
No. 4	53-73
No. 8	38-60
No. 16	26-48
No. 30	18-38
No. 50	11-27
No. 100	6-18
No. 200	3-6

2.2 ASPHALT CEMENT BINDER

Asphalt cement binder shall conform to ASTM D 3381 Table 2, Viscosity Grade AC5AASHTO MP 1a Performance Grade (PG) 120 ASTM D 946 Penetration Grade AR2000. Test data indicating grade certification shall be provided by the supplier at the time of delivery of each load to the mix plant. Copies of these certifications shall be submitted to the Contracting OfficerEngineer. The supplier is defined as the last source of any modification to the binder. The Contracting OfficerEngineer may sample and test the binder at the mix plant at any time before or during mix production. Samples for this verification testing shall be obtained by the Contractor in accordance with ASTM D 140 and in the presence of the Contracting OfficerEngineer. These samples shall be furnished to the Contracting OfficerEngineer for the verification testing, which shall be at no cost to the Contractor. Samples of the asphalt cement specified shall be submitted for approval not less than 14 days before start of the test section.

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2.3 MIX DESIGN

The Contractor shall develop the mix design. The asphalt mix shall be composed of a mixture of well-graded aggregate, mineral filler if required, and asphalt material. The aggregate fractions shall be sized, handled in separate size groups, and combined in such proportions that the resulting mixture meets the grading requirements of the job mix formula (JMF). No hot-mix asphalt for payment shall be produced until a JMF has been approved. The hot-mix asphalt shall be designed using procedures contained in **AI MS-02** and the criteria shown in Table II. If the Tensile Strength Ratio (TSR) of the composite mixture, as determined by **ASTM D 4867/D 4867M** is less than 75, the aggregates shall be rejected or the asphalt mixture treated with an approved anti-stripping agent. The amount of anti-stripping agent added shall be sufficient to produce a TSR of not less than 75. If an antistrip agent is required, it shall be provided by the Contractor at no additional cost.

2.3.1 JMF Requirements

The job mix formula shall be submitted in writing by the Contractor for approval at least 14 days prior to the start of the test section and shall include as a minimum:

- a. Percent passing each sieve size.
- b. Percent of asphalt cement.
- c. Percent of each aggregate and mineral filler to be used.
- d. Asphalt viscosity grade, penetration grade, or performance grade.
- e. Number of blows of hammer per side of molded specimen.
- f. Laboratory mixing temperature.
- g. Lab compaction temperature.
- h. Temperature-viscosity relationship of the asphalt cement.
- i. Plot of the combined gradation on the 0.45 power gradation chart, stating the nominal maximum size.
- j. Graphical plots of stability, flow, air voids, voids in the mineral aggregate, and unit weight versus asphalt content as shown in **AI MS-02**.
- k. Specific gravity and absorption of each aggregate.
- l. Percent natural sand.
- m. Percent particles with two or more fractured faces (in coarse aggregate).
- n. Fine aggregate angularity.
- o. Percent flat or elongated particles (in coarse aggregate).
- p. Tensile Strength Ratio.

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- q. Antistrip agent (if required) and amount.
- r. List of all modifiers and amount.
- s. Percentage and properties (asphalt content, binder properties, and aggregate properties) of RAP in accordance with paragraph RECYCLED HOT-MIX ASPHALT, if RAP is used.

Table II. Marshall Design Criteria

Test Property	75 Blow Mix
Stability, pounds minimum	*2150
Flow, 0.01 inch	8-16
Air voids, percent	3-5
Percent Voids in mineral aggregate (minimum)	See Table III
TSR, minimum percent	75

* This is a minimum requirement. The average during construction shall be significantly higher than this number to ensure compliance with the specifications.

Table III. Minimum Percent Voids in Mineral Aggregate (VMA)**

Aggregate (See Table 2)	Minimum VMA, percent
Gradation 1	14.0

** Calculate VMA in accordance with [AI MS-02](#), based on [ASTM D 2726](#) bulk specific gravity for the aggregate.

2.3.2 Adjustments to JMF

The JMF for each mixture shall be in effect until a new formula is approved in writing by the [Contracting Officer](#). Should a change in sources of any materials be made, a new mix design shall be performed and a new JMF approved before the new material is used. The Contractor will be allowed to adjust the JMF within the limits specified below to optimize mix volumetric properties. Adjustments to the JMF shall be limited to plus or minus 3 percent on the [1/2 inch](#), [No. 4](#), and [No. 8](#) sieves; plus or minus 1.0 percent on the [No. 200](#) sieve; and plus or minus 0.40 percent binder content. If adjustments are needed that exceed these limits, a new mix design shall be developed. Tolerances given above may permit the aggregate grading to be outside the limits shown in Table I; this is acceptable.

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2.4 SOURCE QUALITY CONTROL

Employ a commercial laboratory approved by the Contracting Officer to perform testing. The laboratory used to develop the JMF and the laboratory used to perform all sampling and testing shall meet the requirements of ASTM D 3666. A certification signed by the manager of the laboratory stating that it meets these requirements or clearly listing all deficiencies shall be submitted to the Contracting Officer prior to the start of construction. The certification shall contain as a minimum:

- a. Qualifications of personnel; laboratory manager, supervising technician, and testing technicians.
- b. A listing of equipment to be used in developing the job mix.
- c. A copy of the laboratory's quality control system.
- d. Evidence of participation in the AASHTO Materials Reference Laboratory (AMRL) program.

2.4.1 Tests

Perform testing in accordance with the following:

- a. Specific Gravity Test of Asphalt: ASTM D 70
- b. Coarse Aggregate Tests:
 - (1) Bulk Specific Gravity: ASTM C 127
 - (2) Abrasion Loss: ASTM C 131
 - (3) Soundness Loss: ASTM C 88
- c. Weight of Slag Test: ASTM C 29/C 29M
- d. Percent of Crushed Pieces in Gravel: Count by observation and weight
- e. Fine Aggregate Tests:
 - (1) Bulk Specific Gravity: ASTM C 128
 - (2) Soundness Loss: ASTM C 88
- f. Specific Gravity of Mineral Filler: ASTM C 188 or ASTM D 854
- g. Bituminous Mixture Tests:
 - (1) Bulk Specific Gravity: ASTM D 1188 or ASTM D 2726
 - (2) Theoretical Maximum Specific Gravity: ASTM D 2041
 - (3) Tensile Strength Ratio: ASTM D 4867/D 4867M

2.4.2 Specimens

ASTM D 1559 for the making and testing of bituminous specimens with the following exceptions:

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- a. Compaction: Apply 75 blows of the hammer to each flat face of the specimens for all mix numbers.
- b. Curves: Plot curves for the wearing course to show the effect on the test properties of at least four different percentages of asphalt on the unit weight, stability, flow, air voids, and voids in mineral aggregate; each point on the curves shall represent the average of at least four specimens.
- c. Cooling of Specimen: After compaction is completed, allow the specimen to cool in air to the same temperature approximately as that of the water, 77 degrees F, to be used in the specific gravity determination.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Preparation of Asphalt Binder Material

The asphalt cement material shall be heated avoiding local overheating and providing a continuous supply of the asphalt material to the mixer at a uniform temperature. The temperature of unmodified asphalts shall be no more than 160 degrees C 325 degrees F when added to the aggregates. Modified asphalts shall be no more than 174 degrees C 350 degrees F when added to the aggregate.

3.1.2 Preparation of Mineral Aggregates

Store different size aggregate in separate stockpiles so that different sizes will not mix. Stockpile different-sized aggregates in uniform layers by use of a clam shell or other approved method so as to prevent segregation. The use of bulldozers in stockpiling of aggregate or in feeding aggregate to the dryer is prohibited. Feed aggregates into the cold elevator by means of separate mechanical feeders so that aggregates are graded within requirements of the job-mix formulas and tolerances specified. Regulate rates of feed of the aggregates so that moisture content and temperature of aggregates are within tolerances specified herein. Dry and heat aggregates to the temperature necessary to achieve the mixture determined by the job mix formula within the job tolerance specified. Provide adequate dry storage for mineral filler.

3.1.3 Preparation of Bituminous Mixture

Accurately weigh aggregates and dry mineral filler and convey into the mixer in the proportionate amounts of each aggregate size required to meet the job-mix formula. In batch mixing, after aggregates and mineral filler have been introduced into the mixer and mixed for not less than 15 seconds, add asphalt by spraying or other approved methods and continue mixing for a period of not less than 20 seconds, or as long as required to obtain a homogeneous mixture. The time required to add or spray asphalt into the mixer will not be added to the total wet-mixing time provided the operation does not exceed 10 seconds and a homogeneous mixture is obtained. When a continuous mixer is employed, mixing time shall be more than 35 seconds to obtain a homogeneous mixture. Additional mixing time, when required, will be as directed by the Contracting Officer. When mixture is prepared in a twin-pugmill mixer, volume of the aggregates, mineral filler, and asphalt

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shall not extend above tips of mixer blades when blades are in a vertical position. Overheated and carbonized mixtures, or mixtures that foam or show indication of free moisture, will be rejected. When free moisture is detected in batch or continuous mix plant produced mixtures, waste the mix and withdraw the aggregates in the hot bins immediately and return to the respective stockpiles; for drum-dryer mixer plants, waste the mix, including that in surge or storage bins that is affected by free moisture.

3.1.4 Transportation of Bituminous Mixtures

Transport bituminous material from the mixing plant to the paving site in trucks having tight, clean, smooth beds that have been coated with a minimum amount of concentrated solution of hydrated lime and water or other approved coating to prevent adhesion of the mixture to the truck. Petroleum products will not be permitted for coating truck. If air temperature is less than 60 degrees F or if haul time is greater than 30 minutes, cover each load with canvas or other approved material of ample size to protect the mixture from the loss of heat. Make deliveries so that the spreading and rolling of all the mixture prepared for one day's run can be completed during daylight, unless adequate approved artificial lighting is provided. Deliver mixture to area to be paved so that the temperature at the time of dumping into the spreader is within the range specified herein. Reject loads that are below minimum temperature, that have crusts of cold unworkable material, or that have been wet excessively by rain. Hauling over freshly laid material is prohibited.

3.1.5 Surface Preparation of Underlying Course

Prior to the laying of the asphalt concrete, clean underlying course of foreign or objectionable matter with power blowers or power brooms, supplemented by hand brooms and other cleaning methods where necessary. During the placement of multiple lifts of bituminous concrete, each succeeding lift of bituminous concrete shall have its underlying lift cleaned and provided with a bituminous tack coat if the time period between the placement of each lift of bituminous concrete exceeds 14 days, or the underlying bituminous concrete has become dirty.

3.1.6 Spraying of Contact Surfaces

Paint contact surfaces of structures with a thin coat of emulsion or other approved bituminous material prior to placing the bituminous mixture. Tack coat the previously placed primed coats on base courses when surface has become excessively dirty and cannot be cleaned or when primed surface has cured to the extent that it has lost all bonding effect.

3.2 PLACEMENT

3.2.1 Machine Spreading

The range of temperatures of the mixtures at the time of spreading shall be between 260 degrees F and 300 degrees F. Bituminous concrete having temperatures less than minimum spreading temperature when dumped into the spreader will be rejected. Adjust spreader and regulate speed so that the surface of the course is smooth and continuous without tears and pulling, and of such depth that, when compacted, the surface conforms with the cross section, grade, and contour indicated. Unless otherwise directed, begin the placing along the centerline of areas to be paved on a crowned section or on the high side of areas with a one-way slope. Place mixture in consecutive adjacent strips having a minimum width of 10 feet, except where

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the edge lanes require strips less than 10 feet to complete the area. Construct longitudinal joints and edges to true line markings. Establish lines parallel to the centerline of the area to be paved, and place string lines coinciding with the established lines for the spreading machine to follow. Provide the number and location of the lines needed to accomplish proper grade control. When specified grade and smoothness requirements can be met for initial lane construction by use of an approved long ski-type device of not less than 30 feet in length and for subsequent lane construction by use of a short ski or shoe, in-place string lines for grade control may be omitted. Place mixture as nearly continuous as possible and adjust the speed of placing as needed to permit proper rolling.

3.2.2 Shoveling, Raking, and Tamping After Machine-Spreading

Shovelers and rakers shall follow the spreading machine. Add or remove hot mixture and rake the mixture as required to obtain a course that when completed will conform to requirements specified herein. Broadcasting or fanning of mixture over areas being compacted is prohibited. When segregation occurs in the mixture during placing, suspend spreading operation until the cause is determined and corrected. Correct irregularities in alinement left by the spreader by trimming directly behind the machine. Immediately after trimming, compact edges of the course by tamping laterally with a metal lute or by other approved methods. Distortion of the course during tamping is prohibited.

3.2.3 Hand-Spreading in Lieu of Machine-Spreading

In areas where the use of machine spreading is impractical, spread mixture by hand. The range of temperatures of the mixtures when dumped onto the area to be paved shall be between 260 and 300 degrees F. Mixtures having temperatures less than minimum spreading temperature when dumped onto the area to be paved will be rejected. Spread hot mixture with rakes in a uniformly loose layer of a thickness that, when compacted, will conform to the required grade, thickness, and smoothness. During hand spreading, place each shovelful of mixture by turning the shovel over in a manner that will prevent segregation. Do not place mixture by throwing or broadcasting from a shovel. Do not dump loads any faster than can be properly handled by the shovelers and rakers.

3.3 COMPACTION OF MIXTURE

Compact mixture by rolling. Begin rolling as soon as placement of mixture will bear rollers. Delays in rolling freshly spread mixture shall not be permitted. Start rolling longitudinally at the extreme sides of the lanes and proceed toward center of pavement, or toward high side of pavement with a one-way slope. Operate rollers so that each trip overlaps the previous adjacent strip by at least one foot. Alternate trips of the roller shall be of slightly different lengths. Conduct tests for conformity with the specified crown, grade and smoothness immediately after initial rolling. Before continuing rolling, correct variations by removing or adding materials as necessary. If required, subject course to diagonal rolling with the steel wheeled roller crossing the lines of the previous rolling while mixture is hot and in a compactible condition. Speed of the rollers shall be slow enough to avoid displacement of hot mixture. Correct displacement of mixture immediately by use of rakes and fresh mixture, or remove and replace mixture as directed. Continue rolling until roller marks are eliminated and course has a density of at least 05 percent but not more than 100 percent of that attained in a laboratory specimen of the same mixture prepared in accordance with ASTM D 1559. During rolling,

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moisten wheels of the rollers enough to prevent adhesion of mixture to wheels, but excessive water is prohibited. Operation of rollers shall be by competent and experienced operators. Provide sufficient rollers for each spreading machine in operation on the job and to handle plant output. In places not accessible to the rollers, compact mixture thoroughly with hot hand tampers. Skin patching of an area after compaction is prohibited. Remove mixture that becomes mixed with foreign materials or is defective and replace with fresh mixture compacted to the density specified herein. Roller shall pass over unprotected edge of the course only when laying of course is to be discontinued for such length of time as to permit mixture to become cold.

3.4 JOINTS

Joints shall present the same texture and smoothness as other portions of the course, except permissible density at the joint may be up to 2 percent less than the specified course density. Carefully make joints between old and new pavement or within new pavements in a manner to ensure a thorough and continuous bond between old and new sections of the course. Vertical contact surfaces of previously constructed sections that are coated with dust, sand, or other objectionable material shall be painted with a thin uniform coat of emulsion or other approved bituminous material just before placing fresh mixture.

3.4.1 Transverse

Roller shall pass over unprotected end of freshly laid mixture only when laying of course is to be discontinued. Except when an approved bulkhead is used, cut back the edge of previously laid course to expose an even, vertical surface for the full thickness of the course. When required, rake fresh mixture against joints, thoroughly tamp with hot tampers, smooth with hot smoothers, and roll. Transverse joints in adjacent lanes shall be offset a minimum of 2 feet.

3.4.2 Longitudinal Joints

Space 6 inches apart. Do not allow joints to coincide with joints of existing pavement or previously placed courses. Spreader screed shall overlap previously placed lanes 2 to 3 inches and be of such height to permit compaction to produce a smooth dense joint. With a lute, push back mixture placed on the surface of previous lanes to the joint edge. Do not scatter mix. Remove and waste excess material. When edges of longitudinal joints are irregular, honeycombed, or poorly compacted, cut back unsatisfactory sections of joint and expose an even vertical surface for the full thickness of the course. When required, rake fresh mixture against joint, thoroughly tamp with hot tampers, smooth with hot smoothers, and roll while hot.

3.5 FIELD QUALITY CONTROL

3.5.1 Sampling

3.5.1.1 Aggregates At Source

Prior to production and delivery of aggregates, take at least one initial sample in accordance with ASTM D 75 from each stockpile. Collect each sample by taking three incremental samples at random from the source material to make a composite sample of not less than 50 pounds. Repeat the sampling when the material source changes or when testing reveals

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unacceptable deficiencies or variations from the specified grading of materials.

3.5.1.2 Cold Feed Aggregate Sampling

Take two samples daily from the belt conveying materials from the cold feed.

Collect materials in three increments at random to make a representative composite sample of not less than 50 pounds. Take samples in accordance with ASTM D 75.

3.5.1.3 Coarse and Fine Aggregates

Take a 50 pound sample from the cold feed at least once daily for sieve analyses and specific gravity tests. Additional samples may be required to perform more frequent tests when analyses show deficiencies, or unacceptable variances or deviations. The method of sampling is as specified herein for aggregates.

3.5.1.4 Mineral Filler

ASTM D 546. Take samples large enough to provide ample material for testing.

3.5.1.5 Pavement and Mixture

Take plant samples for the determination of mix properties and field samples for thickness and density of the completed pavements. Furnish tools, labor and material for samples, and satisfactory replacement of pavement. Take samples and tests at not less than frequency specified hereinafter and at the beginning of plant operations; for each day's work as a minimum; each change in the mix or equipment; and as often as directed. Accomplish sampling in accordance with ASTM D 979.

3.5.2 Testing

3.5.2.1 Aggregates Tests

- a. Gradation: ASTM C 136.
- b. Mineral Filler Content: ASTM D 546.
- c. Abrasion: ASTM C 131 for wear (Los Angeles test). Perform one test initially prior to incorporation into the work and each time the source is changed.

3.5.2.2 Bituminous Mix Tests

Test one sample for each 500 tons, or fraction thereof, of the uncompacted mix for extraction in accordance with ASTM D 2172; perform a sieve analysis on each extraction sample in accordance with ASTM C 136 and ASTM C 117. Test one sample for each 500 tons or fraction thereof for stability and flow in accordance with ASTM D 1559. Test one sample for each material blend for Tensile Strength Ratio in accordance with ASTM D 4867/D 4867M.

3.5.2.3 Pavement Courses

Perform the following tests:

- a. Density: For each 1000 tons of bituminous mixture placed,

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determine the representative laboratory density by averaging the density of four laboratory specimens prepared in accordance with ASTM D 1559. Samples for laboratory specimens shall be taken from trucks delivering mixture to the site; record in a manner approved by the Contracting Officer the project areas represented by the laboratory densities. From each representative area recorded, determine field density of pavement by averaging densities of 4 inch diameter cores obtained from leveling, binder, and wearing courses; take one core for each 2000 square yards or fraction thereof of course placed. Determine density of laboratory prepared specimens and cored samples in accordance with ASTM D 1188 or ASTM D 2726, as applicable. Separate pavement layers by sawing or other approved means. Maximum allowable deficiency at any point, excluding joints, shall not be more than 2 percent less than the specified density for any course. The average density of each course, excluding joints, shall be not less than the specified density. Joint densities shall not be more than 2 percent less than specified course densities and are not included when calculating average course densities. When the deficiency exceeds the specified tolerances, correct each such representative area or areas by removing the deficient pavement and replacing with new pavement.

- b. Thickness: Determine thickness of wearing courses from samples taken for the field density test. The maximum allowable deficiency at any point shall not be more than 1/4 inch less than the thickness for the indicated course. Average thickness of course or of combined courses shall be not less than the indicated thickness. Where a deficiency exceeds the specified tolerances, correct each such representative area or areas by removing the deficient pavement and replacing with new pavement.
- c. Smoothness: Straightedge test the compacted surface of wearing course as work progresses. Apply straightedge parallel with and at right angles to the centerline after final rolling. Correct each portion of the pavement showing irregularities greater than that specified.
- d. Finish Surface Texture of Wearing Course: Visually check final surface texture for uniformity and reasonable compactness and tightness. Final wearing course with a surface texture having undesirable irregularities such as segregation, cavities, pulls or tears, checking, excessive exposure of coarse aggregates, sand streaks, indentations, ripples, or lack of uniformity shall be removed and replaced with new materials.

3.6 PROTECTION

Do not permit vehicular traffic, including heavy equipment, on pavement until surface temperature has cooled to at least 120 degrees F. Measure surface temperature by approved surface thermometers or other satisfactory methods.

-- End of Section --

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CONCRETE SIDEWALKS AND CURBS AND GUTTERS

04/08

PART 1 GENERAL

1.1 MEASUREMENT FOR PAYMENT

1.1.1 Sidewalks

The quantities of sidewalks to be paid for will be the number of square yards of each depth of sidewalk constructed as indicated.

1.1.2 Curbs and Gutters

The quantities of curbs and gutters to be paid for will be the number of linear feet of each cross section constructed as indicated, measured along the face of the curb at the gutter line.

1.2 BASIS FOR PAYMENT

1.2.1 Sidewalks

Payment of the quantities of sidewalks measured as specified will be at the contract unit price per square yard of the thickness specified.

1.2.2 Curbs and Gutters

Payment of the quantities of curbs and gutters measured as specified will be at the contract unit price per linear foot of each cross section.

1.3 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS
(AASHTO)

AASHTO M 182 (2005) Standard Specification for Burlap Cloth Made from Jute or Kenaf and Cotton Mats

ASTM INTERNATIONAL (ASTM)

ASTM A 185/A 185M (2007) Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete

ASTM A 615/A 615M (2007) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement

ASTM C 143/C 143M (2005a) Standard Test Method for Slump of Hydraulic-Cement Concrete

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ASTM C 171	(2007) Standard Specification for Sheet Materials for Curing Concrete
ASTM C 172	(2007) Standard Practice for Sampling Freshly Mixed Concrete
ASTM C 173/C 173M	(2007) Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C 231	(2004) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 309	(2007) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C 31/C 31M	(2006) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C 920	(2005) Standard Specification for Elastomeric Joint Sealants
ASTM D 1751	(2004) Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D 1752	(2004a) Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion
ASTM D 5893	(2004) Cold Applied, Single Component, Chemically Curing Silicone Joint Sealant for Portland Cement Concrete Pavements

1.4 SYSTEM DESCRIPTION

1.4.1 General Requirements

Provide plant, equipment, machines, and tools used in the work subject to approval and maintained in a satisfactory working condition at all times. The equipment shall have the capability of producing the required product, meeting grade controls, thickness control and smoothness requirements as specified. Use of the equipment shall be discontinued if it produces unsatisfactory results. The Contracting Officer shall have access at all times to the plant and equipment to ensure proper operation and compliance with specifications.

1.4.2 Slip Form Equipment

Slip form paver or curb forming machine, will be approved based on trial use on the job and shall be self-propelled, automatically controlled, crawler mounted, and capable of spreading, consolidating, and shaping the plastic concrete to the desired cross section in 1 pass.

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1.5 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Concrete

Copies of certified delivery tickets for all concrete used in the construction.

SD-06 Test Reports

Field Quality Control

Copies of all test reports within 24 hours of completion of the test.

1.6 ENVIRONMENTAL REQUIREMENTS

1.6.1 Placing During Cold Weather

Do not place concrete when the air temperature reaches 40 degrees F and is falling, or is already below that point. Placement may begin when the air temperature reaches 35 degrees F and is rising, or is already above 40 degrees F. Make provisions to protect the concrete from freezing during the specified curing period. If necessary to place concrete when the temperature of the air, aggregates, or water is below 35 degrees F, placement and protection shall be approved in writing. Approval will be contingent upon full conformance with the following provisions. The underlying material shall be prepared and protected so that it is entirely free of frost when the concrete is deposited. Mixing water and aggregates shall be heated as necessary to result in the temperature of the in-place concrete being between 50 and 85 degrees F. Methods and equipment for heating shall be approved. The aggregates shall be free of ice, snow, and frozen lumps before entering the mixer. Covering and other means shall be provided for maintaining the concrete at a temperature of at least 50 degrees F for not less than 72 hours after placing, and at a temperature above freezing for the remainder of the curing period.

1.6.2 Placing During Warm Weather

The temperature of the concrete as placed shall not exceed 85 degrees F except where an approved retarder is used. The mixing water and/or aggregates shall be cooled, if necessary, to maintain a satisfactory placing temperature. The placing temperature shall not exceed 95 degrees F at any time.

PART 2 PRODUCTS

2.1 CONCRETE

Concrete shall have a minimum compressive strength of 3500 psi at 28 days. Maximum size of aggregate shall be 1-1/2 inches.

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2.1.1 Air Content

Mixtures shall have air content by volume of concrete of 5 to 7 percent, based on measurements made immediately after discharge from the mixer.

2.1.2 Slump

The concrete slump shall be 2 inches plus or minus 1 inch where determined in accordance with ASTM C 143/C 143M.

2.1.3 Reinforcement Steel

Reinforcement bars shall conform to ASTM A 615/A 615M. Wire mesh reinforcement shall conform to ASTM A 185/A 185M.

2.2 CONCRETE CURING MATERIALS

2.2.1 Impervious Sheet Materials

Impervious sheet materials shall conform to ASTM C 171, type optional, except that polyethylene film, if used, shall be white opaque.

2.2.2 Burlap

Burlap shall conform to AASHTO M 182.

2.2.3 White Pigmented Membrane-Forming Curing Compound

White pigmented membrane-forming curing compound shall conform to ASTM C 309, Type 2.

2.3 CONCRETE PROTECTION MATERIALS

Concrete protection materials shall be a linseed oil mixture of equal parts, by volume, of linseed oil and either mineral spirits, naphtha, or turpentine. At the option of the Contractor, commercially prepared linseed oil mixtures, formulated specifically for application to concrete to provide protection against the action of deicing chemicals may be used, except that emulsified mixtures are not acceptable.

2.4 JOINT FILLER STRIPS

2.4.1 Contraction Joint Filler for Curb and Gutter

Contraction joint filler for curb and gutter shall consist of hard-pressed fiberboard.

2.4.2 Expansion Joint Filler, Premolded

Expansion joint filler, premolded, shall conform to ASTM D 1751 or ASTM D 1752, 1/2 inch thick, unless otherwise indicated.

2.5 JOINT SEALANTS

Joint sealant, cold-applied shall conform to ASTM C 920 or ASTM D 5893.

2.6 FORM WORK

Design and construct form work to ensure that the finished concrete will

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conform accurately to the indicated dimensions, lines, and elevations, and within the tolerances specified. Forms shall be of wood or steel, straight, of sufficient strength to resist springing during depositing and consolidating concrete. Wood forms shall be surfaced plank, 2 inches nominal thickness, straight and free from warp, twist, loose knots, splits or other defects. Wood forms shall have a nominal length of 10 feet. Radius bends may be formed with 3/4 inch boards, laminated to the required thickness. Steel forms shall be channel-formed sections with a flat top surface and with welded braces at each end and at not less than two intermediate points. Ends of steel forms shall be interlocking and self-aligning. Steel forms shall include flexible forms for radius forming, corner forms, form spreaders, and fillers. Steel forms shall have a nominal length of 10 feet with a minimum of 3 welded stake pockets per form. Stake pins shall be solid steel rods with chamfered heads and pointed tips designed for use with steel forms.

2.6.1 Sidewalk Forms

Sidewalk forms shall be of a height equal to the full depth of the finished sidewalk.

2.6.2 Curb and Gutter Forms

Curb and gutter outside forms shall have a height equal to the full depth of the curb or gutter. The inside form of curb shall have batter as indicated and shall be securely fastened to and supported by the outside form. Rigid forms shall be provided for curb returns, except that benders or thin plank forms may be used for curb or curb returns with a radius of 10 feet or more, where grade changes occur in the return, or where the central angle is such that a rigid form with a central angle of 90 degrees cannot be used. Back forms for curb returns may be made of 1-1/2 inch benders, for the full height of the curb, cleated together. In lieu of inside forms for curbs, a curb "mule" may be used for forming and finishing this surface, provided the results are approved.

PART 3 EXECUTION

3.1 SUBGRADE PREPARATION

The subgrade shall be constructed to the specified grade and cross section prior to concrete placement. Subgrade shall be placed and compacted in conformance with Section 31 23 01.98 EXCAVATION.

3.1.1 Sidewalk Subgrade

The subgrade shall be tested for grade and cross section with a template extending the full width of the sidewalk and supported between side forms.

3.1.2 Curb and Gutter Subgrade

The subgrade shall be tested for grade and cross section by means of a template extending the full width of the curb and gutter. The subgrade shall be of materials equal in bearing quality to the subgrade under the adjacent pavement.

3.1.3 Maintenance of Subgrade

The subgrade shall be maintained in a smooth, compacted condition in conformity with the required section and established grade until the

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concrete is placed. The subgrade shall be in a moist condition when concrete is placed. The subgrade shall be prepared and protected to produce a subgrade free from frost when the concrete is deposited.

3.2 FORM SETTING

Set forms to the indicated alignment, grade and dimensions. Hold forms rigidly in place by a minimum of 3 stakes per form placed at intervals not to exceed 4 feet. Corners, deep sections, and radius bends shall have additional stakes and braces, as required. Clamps, spreaders, and braces shall be used where required to ensure rigidity in the forms. Forms shall be removed without injuring the concrete. Bars or heavy tools shall not be used against the concrete in removing the forms. Any concrete found defective after form removal shall be promptly and satisfactorily repaired. Forms shall be cleaned and coated with form oil each time before concrete is placed. Wood forms may, instead, be thoroughly wetted with water before concrete is placed, except that with probable freezing temperatures, oiling is mandatory.

3.2.1 Sidewalks

Set forms for sidewalks with the upper edge true to line and grade with an allowable tolerance of 1/8 inch in any 10 foot long section. After forms are set, grade and alignment shall be checked with a 10 foot straightedge. Forms shall have a transverse slope of 1/4 inch per foot with the low side adjacent to the roadway. Side forms shall not be removed for 12 hours after finishing has been completed.

3.2.2 Curbs and Gutters

The forms of the front of the curb shall be removed not less than 2 hours nor more than 6 hours after the concrete has been placed. Forms back of curb shall remain in place until the face and top of the curb have been finished, as specified for concrete finishing. Gutter forms shall not be removed while the concrete is sufficiently plastic to slump in any direction.

3.3 SIDEWALK CONCRETE PLACEMENT AND FINISHING

3.3.1 Formed Sidewalks

Place concrete in the forms in one layer. When consolidated and finished, the sidewalks shall be of the thickness indicated. After concrete has been placed in the forms, a strike-off guided by side forms shall be used to bring the surface to proper section to be compacted. The concrete shall be consolidated with an approved vibrator, and the surface shall be finished to grade with a strike off.

3.3.2 Concrete Finishing

After straightedging, when most of the water sheen has disappeared, and just before the concrete hardens, finish the surface with a wood float or darby to a smooth and uniformly fine granular or sandy texture free of waves, irregularities, or tool marks. A scored surface shall be produced by brooming with a fiber-bristle brush in a direction transverse to that of the traffic, followed by edging.

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3.3.3 Edge and Joint Finishing

All slab edges, including those at formed joints, shall be finished with an edger having a radius of $1/8$ inch. Transverse joint shall be edged before brooming, and the brooming shall eliminate the flat surface left by the surface face of the edger. Corners and edges which have crumbled and areas which lack sufficient mortar for proper finishing shall be cleaned and filled solidly with a properly proportioned mortar mixture and then finished.

3.3.4 Surface and Thickness Tolerances

Finished surfaces shall not vary more than $5/16$ inch from the testing edge of a 10-foot straightedge. Permissible deficiency in section thickness will be up to $1/4$ inch.

3.4 CURB AND GUTTER CONCRETE PLACEMENT AND FINISHING

3.4.1 Formed Curb and Gutter

Concrete shall be placed to the section required in a single lift. Consolidation shall be achieved by using approved mechanical vibrators. Curve shaped gutters shall be finished with a standard curb "mule".

3.4.2 Curb and Gutter Finishing

Approved slipformed curb and gutter machines may be used in lieu of hand placement.

3.4.3 Concrete Finishing

Exposed surfaces shall be floated and finished with a smooth wood float until true to grade and section and uniform in texture. Floated surfaces shall then be brushed with a fine-hair brush with longitudinal strokes. The edges of the gutter and top of the curb shall be rounded with an edging tool to a radius of $1/2$ inch. Immediately after removing the front curb form, the face of the curb shall be rubbed with a wood or concrete rubbing block and water until blemishes, form marks, and tool marks have been removed. The front curb surface, while still wet, shall be brushed in the same manner as the gutter and curb top. The top surface of gutter and entrance shall be finished to grade with a wood float.

3.4.4 Joint Finishing

Curb edges at formed joints shall be finished as indicated.

3.4.5 Surface and Thickness Tolerances

Finished surfaces shall not vary more than $1/4$ inch from the testing edge of a 10-foot straightedge. Permissible deficiency in section thickness will be up to $1/4$ inch.

3.5 SIDEWALK JOINTS

Sidewalk joints shall be constructed to divide the surface into rectangular areas. Transverse contraction joints shall be spaced at a distance equal to the sidewalk width or 5 feet on centers, whichever is less, and shall be continuous across the slab. Longitudinal contraction joints shall be constructed along the centerline of all sidewalks 10 feet or more in

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width. Transverse expansion joints shall be installed at sidewalk returns and opposite expansion joints in adjoining curbs. Where the sidewalk is not in contact with the curb, transverse expansion joints shall be installed as indicated. Expansion joints shall be formed about structures and features which project through or into the sidewalk pavement, using joint filler of the type, thickness, and width indicated. Expansion joints are not required between sidewalks and curb that abut the sidewalk longitudinally.

3.5.1 Sidewalk Contraction Joints

The contraction joints shall be formed in the fresh concrete by cutting a groove in the top portion of the slab to a depth of at least one-fourth of the sidewalk slab thickness, using a jointer to cut the groove, or by sawing a groove in the hardened concrete with a power-driven saw, unless otherwise approved. Sawed joints shall be constructed by sawing a groove in the concrete with a 1/8 inch blade to the depth indicated. An ample supply of saw blades shall be available on the job before concrete placement is started, and at least one standby sawing unit in good working order shall be available at the jobsite at all times during the sawing operations.

3.5.2 Sidewalk Expansion Joints

Expansion joints shall be formed with 1/2 inch joint filler strips. Joint filler in expansion joints surrounding structures and features within the sidewalk may consist of preformed filler material conforming to ASTM D 1752 or building paper. Joint filler shall be held in place with steel pins or other devices to prevent warping of the filler during floating and finishing. Immediately after finishing operations are completed, joint edges shall be rounded with an edging tool having a radius of 1/8 inch, and concrete over the joint filler shall be removed. At the end of the curing period, expansion joints shall be cleaned and filled with cold-applied joint sealant. Joint sealant shall be gray or stone in color. The joint opening shall be thoroughly cleaned before the sealing material is placed. Sealing material shall not be spilled on exposed surfaces of the concrete. Concrete at the joint shall be surface dry and atmospheric and concrete temperatures shall be above 50 degrees F at the time of application of joint sealing material. Excess material on exposed surfaces of the concrete shall be removed immediately and concrete surfaces cleaned.

3.5.3 Reinforcement Steel Placement

Reinforcement steel shall be accurately and securely fastened in place with suitable supports and ties before the concrete is placed.

3.6 CURB AND GUTTER JOINTS

Curb and gutter joints shall be constructed at right angles to the line of curb and gutter.

3.6.1 Contraction Joints

Contraction joints shall be constructed directly opposite contraction joints in abutting portland cement concrete pavements and spaced so that monolithic sections between curb returns will not be less than 5 feet nor greater than 15 feet in length.

- a. Contraction joints (except for slip forming) shall be constructed

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by means of 1/8 inch thick separators and of a section conforming to the cross section of the curb and gutter. Separators shall be removed as soon as practicable after concrete has set sufficiently to preserve the width and shape of the joint and prior to finishing.

b. When slip forming is used, the contraction joints shall be cut in the top portion of the gutter/curb hardened concrete in a continuous cut across the curb and gutter, using a power-driven saw. The depth of cut shall be at least one-fourth of the gutter/curb depth and 1/8 inch in width.

3.6.2 Expansion Joints

Expansion joints shall be formed by means of preformed expansion joint filler material cut and shaped to the cross section of curb and gutter. Expansion joints shall be provided in curb and gutter directly opposite expansion joints of abutting portland cement concrete pavement, and shall be of the same type and thickness as joints in the pavement. Where curb and gutter do not abut portland cement concrete pavement, expansion joints at least 1/2 inch in width shall be provided at intervals not less than 30 feet nor greater than 120 feet. Expansion joints shall be provided in nonreinforced concrete gutter at locations indicated. Expansion joints shall be sealed immediately following curing of the concrete or as soon thereafter as weather conditions permit. Expansion joints and the top 1 inch depth of curb and gutter contraction-joints shall be sealed with joint sealant. The joint opening shall be thoroughly cleaned before the sealing material is placed. Sealing material shall not be spilled on exposed surfaces of the concrete. Concrete at the joint shall be surface dry and atmospheric and concrete temperatures shall be above 50 degrees F at the time of application of joint sealing material. Excess material on exposed surfaces of the concrete shall be removed immediately and concrete surfaces cleaned.

3.7 CURING AND PROTECTION

3.7.1 General Requirements

Protect concrete against loss of moisture and rapid temperature changes for at least 7 days from the beginning of the curing operation. Protect unhardened concrete from rain and flowing water. All equipment needed for adequate curing and protection of the concrete shall be on hand and ready for use before actual concrete placement begins. Protection shall be provided as necessary to prevent cracking of the pavement due to temperature changes during the curing period.

3.7.1.1 Mat Method

The entire exposed surface shall be covered with 2 or more layers of burlap. Mats shall overlap each other at least 6 inches. The mat shall be thoroughly wetted with water prior to placing on concrete surface and shall be kept continuously in a saturated condition and in intimate contact with concrete for not less than 7 days.

3.7.1.2 Impervious Sheeting Method

The entire exposed surface shall be wetted with a fine spray of water and then covered with impervious sheeting material. Sheets shall be laid directly on the concrete surface with the light-colored side up and overlapped 12 inches when a continuous sheet is not used. The curing

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medium shall not be less than 18-inches wider than the concrete surface to be cured, and shall be securely weighted down by heavy wood planks, or a bank of moist earth placed along edges and laps in the sheets. Sheets shall be satisfactorily repaired or replaced if torn or otherwise damaged during curing. The curing medium shall remain on the concrete surface to be cured for not less than 7 days.

3.7.1.3 Membrane Curing Method

A uniform coating of white-pigmented membrane-curing compound shall be applied to the entire exposed surface of the concrete as soon after finishing as the free water has disappeared from the finished surface. Formed surfaces shall be coated immediately after the forms are removed and in no case longer than 1 hour after the removal of forms. Concrete shall not be allowed to dry before the application of the membrane. If any drying has occurred, the surface of the concrete shall be moistened with a fine spray of water and the curing compound applied as soon as the free water disappears. Curing compound shall be applied in two coats by hand-operated pressure sprayers at a coverage of approximately 200 square feet/gallon for the total of both coats. The second coat shall be applied in a direction approximately at right angles to the direction of application of the first coat. The compound shall form a uniform, continuous, coherent film that will not check, crack, or peel and shall be free from pinholes or other imperfections. If pinholes, abrasion, or other discontinuities exist, an additional coat shall be applied to the affected areas within 30 minutes. Concrete surfaces that are subjected to heavy rainfall within 3 hours after the curing compound has been applied shall be resprayed by the method and at the coverage specified above. Areas where the curing compound is damaged by subsequent construction operations within the curing period shall be resprayed. Necessary precautions shall be taken to insure that the concrete is properly cured at sawed joints, and that no curing compound enters the joints. The top of the joint opening and the joint groove at exposed edges shall be tightly sealed before the concrete in the region of the joint is resprayed with curing compound. The method used for sealing the joint groove shall prevent loss of moisture from the joint during the entire specified curing period. Approved standby facilities for curing concrete pavement shall be provided at a location accessible to the jobsite for use in the event of mechanical failure of the spraying equipment or other conditions that might prevent correct application of the membrane-curing compound at the proper time. Concrete surfaces to which membrane-curing compounds have been applied shall be adequately protected during the entire curing period from pedestrian and vehicular traffic, except as required for joint-sawing operations and surface tests, and from any other possible damage to the continuity of the membrane.

3.7.2 Backfilling

After curing, debris shall be removed and the area adjoining the concrete shall be backfilled, graded, and compacted to conform to the surrounding area in accordance with lines and grades indicated.

3.7.3 Protection

Completed concrete shall be protected from damage until accepted. Repair damaged concrete and clean concrete discolored during construction. Concrete that is damaged shall be removed and reconstructed for the entire length between regularly scheduled joints. Refinishing the damaged portion will not be acceptable. Removed damaged portions shall be disposed of as

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directed.

3.7.4 Protective Coating

Protective coating, of linseed oil mixture, shall be applied to the exposed-to-view concrete surface after the curing period, if concrete will be exposed to de-icing chemicals within 6 weeks after placement. Concrete to receive a protective coating shall be moist cured.

3.7.4.1 Application

Curing and backfilling operation shall be completed prior to applying two coats of protective coating. Concrete shall be surface dry and clean before each application. Coverage shall be by spray application at not more than 50 square yards/gallon for first application and not more than 70 square yards/gallon for second application, except that the number of applications and coverage for each application for commercially prepared mixture shall be in accordance with the manufacturer's instructions. Coated surfaces shall be protected from vehicular and pedestrian traffic until dry.

3.7.4.2 Precautions

Protective coating shall not be heated by direct application of flame or electrical heaters and shall be protected from exposure to open flame, sparks, and fire adjacent to open containers or applicators. Material shall not be applied at ambient or material temperatures lower than 50 degrees F.

3.8 FIELD QUALITY CONTROL

3.8.1 General Requirements

Perform the inspection and tests described and meet the specified requirements for inspection details and frequency of testing. Based upon the results of these inspections and tests, take the action and submit reports as required below, and any additional tests to insure that the requirements of these specifications are met.

3.8.2 Concrete Testing

3.8.2.1 Strength Testing

Provide molded concrete specimens for strength tests. Samples of concrete placed each day shall be taken not less than once a day nor less than once for every 250 cubic yards of concrete. The samples for strength tests shall be taken in accordance with ASTM C 172. Cylinders for acceptance shall be molded in conformance with ASTM C 31/C 31M by an approved testing laboratory. Each strength test result shall be the average of 2 test cylinders from the same concrete sample tested at 28 days, unless otherwise specified or approved. Concrete specified on the basis of compressive strength will be considered satisfactory if the averages of all sets of three consecutive strength test results equal or exceed the specified strength, and no individual strength test result falls below the specified strength by more than 500 psi.

3.8.2.2 Air Content

Determine air content in accordance with ASTM C 173/C 173M or ASTM C 231.

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ASTM C 231 shall be used with concretes and mortars made with relatively dense natural aggregates. Two tests for air content shall be made on randomly selected batches of each class of concrete placed during each shift. Additional tests shall be made when excessive variation in concrete workability is reported by the placing foreman or the Government inspector. If results are out of tolerance, the placing foreman shall be notified and he shall take appropriate action to have the air content corrected at the plant. Additional tests for air content will be performed on each truckload of material until such time as the air content is within the tolerance specified.

3.8.2.3 Slump Test

Two slump tests shall be made on randomly selected batches of each class of concrete for every 250 cubic yards, or fraction thereof, of concrete placed during each shift. Additional tests shall be performed when excessive variation in the workability of the concrete is noted or when excessive crumbling or slumping is noted along the edges of slip-formed concrete.

3.8.3 Thickness Evaluation

The anticipated thickness of the concrete shall be determined prior to placement by passing a template through the formed section or by measuring the depth of opening of the extrusion template of the curb forming machine. If a slip form paver is used for sidewalk placement, the subgrade shall be true to grade prior to concrete placement and the thickness will be determined by measuring each edge of the completed slab.

3.8.4 Surface Evaluation

The finished surface of each category of the completed work shall be uniform in color and free of blemishes and form or tool marks.

3.9 SURFACE DEFICIENCIES AND CORRECTIONS

3.9.1 Thickness Deficiency

When measurements indicate that the completed concrete section is deficient in thickness by more than 1/4 inch the deficient section will be removed, between regularly scheduled joints, and replaced.

3.9.2 High Areas

In areas not meeting surface smoothness and plan grade requirements, high areas shall be reduced either by rubbing the freshly finished concrete with carborundum brick and water when the concrete is less than 36 hours old or by grinding the hardened concrete with an approved surface grinding machine after the concrete is 36 hours old or more. The area corrected by grinding the surface of the hardened concrete shall not exceed 5 percent of the area of any integral slab, and the depth of grinding shall not exceed 1/4 inch. Pavement areas requiring grade or surface smoothness corrections in excess of the limits specified above shall be removed and replaced.

3.9.3 Appearance

Exposed surfaces of the finished work will be inspected by the Government and any deficiencies in appearance will be identified. Areas which exhibit excessive cracking, discoloration, form marks, or tool marks or which are otherwise inconsistent with the overall appearances of the work shall be

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removed and replaced.

-- End of Section --

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PAVEMENT MARKINGS

04/06

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D 2240	(2005) Standard Test Method for Rubber Property - Durometer Hardness
ASTM D 2621	(1987; R 2005) Infrared Identification of Vehicle Solids from Solvent-Reducible Paints
ASTM D 2697	(2003) Volume Nonvolatile Matter in Clear or Pigmented Coatings
ASTM D 3335	(1985a; R 2005) Low Concentrations of Lead, Cadmium, and Cobalt in Paint by Atomic Absorption Spectroscopy
ASTM D 3718	(1985a; R 2005) Low Concentrations of Chromium in Paint by Atomic Absorption Spectroscopy
ASTM D 3924	(1980; R 2005) Standard Environment for Conditioning and Testing Paint, Varnish, Lacquer, and Related Materials
ASTM D 3960	(2005) Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings
ASTM D 4280	(2004) Extended Life Type, Nonplowable, Raised, Retroreflective Pavement Markers
ASTM D 4505	(2005) Preformed Retroreflective Pavement Marking Tape for Extended Service Life
ASTM D 4541	(2002) Pull-Off Strength of Coatings Using Portable Adhesion Testers
ASTM D 471	(2006) Standard Test Method for Rubber Property - Effect of Liquids
ASTM D 522	(1993a; R 2001) Mandrel Bend Test of Attached Organic Coatings
ASTM D 711	(1989; R 2004) No-Pick-Up Time of Traffic Paint

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ASTM D 792	(2000) Density and Specific Gravity (Relative Density) of Plastics by Displacement
ASTM D 823	(1995; R 2007) Producing Films of Uniform Thickness of Paint, Varnish, and Related Products on Test Panels.
ASTM E 28	(1999; R 2004) Softening Point of Resins Derived from Naval Stores by Ring and Ball Apparatus
ASTM G 53	(1996) Operating Light- and Water-Exposure Apparatus (Fluorescent UV-Condensation Type) for Exposure of Nonmetallic Materials

INTERNATIONAL CONCRETE REPAIR INSTITUTE (ICRI)

ICRI 03732	(1997) Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays
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U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FED-STD-595	(Rev B; Am 1) Colors Used in Government Procurement
FS TT-B-1325	(Rev C) Beads (Glass Spheres) Retro-Reflective (Metric)
FS TT-P-1952	(Rev D) Paint, Traffic and Airfield Markings, Waterborne

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Reflective media for roads and streets

Paints for roads and streets

High Build Acrylic Coating (HBAC); G

Thermoplastic compound

Raised Pavement Markers and Adhesive

Lists of proposed equipment, including descriptive data, and notifications of proposed Contractor actions as specified in this section. List of removal equipment shall include descriptive data indicating area of coverage per pass, pressure adjustment range, tank and flow capacities, and safety precautions required for the

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equipment operation.

Qualifications

Documentation on personnel qualifications, as specified.

SD-06 Test Reports

Reflective media for roads and streets

Paints for roads and streets

High Build Acrylic Coating (HBAC); G

Thermoplastic compound

Raised Pavement Markers and Adhesive

Certified reports from sampling and testing made in accordance with paragraph entitled "Sampling and Testing" prior to the use of the materials at the jobsite. Testing shall be performed in an approved independent laboratory.

SD-07 Certificates

Reflective media for roads and streets

Paints for roads and streets

Volatile Organic Compound, (VOC)

Certificate stating that the proposed pavement marking paint meets the VOC regulations of the local Air Pollution Control District having jurisdiction over the geographical area in which the project is located.

Thermoplastic compound

Construction equipment list

SD-08 Manufacturer's Instructions

Paints for roads and streets

Thermoplastic compound

Submit manufacturer's Material Safety Data Sheets.

1.3 DELIVERY AND STORAGE

Deliver paints, paint materials and thermoplastic compound materials in original sealed containers that plainly show the designated name, specification number, batch number, color, date of manufacture, manufacturer's directions, and name of manufacturer. Provide storage

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facilities at the job site, only in areas approved by the Contracting Officer or authorized representative, for maintaining materials at temperatures recommended by the manufacturer.

1.4 WEATHER LIMITATIONS

Apply paint to clean, dry surfaces, and unless otherwise approved, only when the air and pavement surface temperature is at least 5 degrees above the dew point and the air and pavement temperatures are above 40 degrees F and less than 95 degrees F for oil-based materials; above 50 degrees F and less than 110 degrees F for water-based materials. Maintain paint temperature within these same limits.

1.5 EQUIPMENT

Machines, tools, and equipment used in the performance of the work shall be approved by the Contracting Officer and maintained in satisfactory operating condition. Submit construction equipment list for approval by the Contracting Officer.

1.5.1 Mobile and Maneuverable

Application equipment shall be mobile and maneuverable to the extent that straight lines can be followed and normal curves can be made in a true arc.

1.5.2 Paint Application Equipment

1.5.2.1 Self-Propelled or Mobile-Drawn Pneumatic Spraying Machines

Provide self-propelled or mobile-drawn pneumatic spraying machine with suitable arrangements of atomizing nozzles and controls to obtain the specified results. Provide machine having a speed during application capable of applying the stripe widths indicated at the paint coverage rate specified herein and of even uniform thickness with clear-cut edges. Provide equipment used for marking streets and highways capable of placing the prescribed number of lines at a single pass as solid lines, intermittent lines, or a combination of solid and intermittent lines using a maximum of three different colors of paint as specified. Provide paint applicator with paint reservoirs or tanks of sufficient capacity and suitable gages to apply paint in accordance with requirements specified. Equip tanks with suitable air-driven mechanical agitators. Equip spray mechanism with quick-action valves conveniently located, and include necessary pressure regulators and gages in full view and reach of the operator. Install paint strainers in paint supply lines to ensure freedom from residue and foreign matter that may cause malfunction of the spray guns. The paint applicator shall be readily adaptable for attachment of an air-actuated dispenser for the reflective media approved for use. Provide pneumatic spray guns for hand application of paint in areas where the mobile paint applicator cannot be used. Applicator for water-based markings shall be equipped with non-stick coated hoses; metal parts in contact with the paint material shall be constructed of grade 302, 304, 316, or equal stainless steel.

1.5.3 Thermoplastic Application Equipment

1.5.3.1 Thermoplastic Material

Thermoplastic material shall be applied to the primed pavement surface by

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spray techniques or by the extrusion method, wherein one side of the shaping die is the pavement and the other three sides are contained by, or are part of, suitable equipment for heating and controlling the flow of material. By either method, the markings shall be applied with equipment that is capable of providing continuous uniformity in the dimensions of the stripe.

1.5.3.2 Application Equipment

a. Application equipment shall provide continuous mixing and agitation of the material. Conveying parts of the equipment between the main material reservoir and the extrusion shoe or spray gun shall prevent accumulation and clogging. All parts of the equipment which come into contact with the material shall be easily accessible and exposable for cleaning and maintenance. All mixing and conveying parts up to and including the extrusion shoes and spray guns shall maintain the material at the required temperature with heat-transfer oil or electrical-element-controlled heat.

b. The application equipment shall be constructed to ensure continuous uniformity in the dimensions of the stripe. The applicator shall provide a means for cleanly cutting off stripe ends squarely and shall provide a method of applying "skiplines". The equipment shall be capable of applying varying widths of traffic markings.

c. The applicator shall be equipped with a drop-on type bead dispenser capable of uniformly dispensing reflective glass spheres at controlled rates of flow. The bead dispenser shall be automatically operated and shall begin flow prior to the flow of composition to assure that the strip is fully reflectorized.

1.5.3.3 Mobile and Maneuverable

Application equipment shall be mobile and maneuverable to the extent that straight lines can be followed and normal curves can be made in a true arc. The equipment used for the placement of thermoplastic pavement markings shall be of two general types: mobile applicator and portable applicator.

1.5.3.4 Mobile Application Equipment

The mobile applicator shall be defined as a truck-mounted, self-contained pavement marking machine that is capable of hot applying thermoplastic by either the extrusion or spray method. The unit shall be equipped to apply the thermoplastic marking material at temperatures exceeding 375 degrees F, at widths varying from 3 to 12 inches and in thicknesses varying from 0.040 to 0.200 inch and shall have an automatic drop-on bead system. The mobile unit shall be capable of operating continuously and of installing a minimum of 20,000 lineal feet of longitudinal markings in an 8-hour day.

The mobile unit shall be equipped with a melting kettle which holds a minimum of 6000 pounds of molten thermoplastic material. The kettle shall be capable of heating the thermoplastic composition to temperatures of 375 to 425 degrees F. A thermostatically controlled heat transfer liquid shall be used. Heating of the composition by direct flame shall not be allowed. Oil and material temperature gauges shall be visible at both ends of the kettle.

The mobile unit shall be equipped with an electronic programmable line

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pattern control system. The control system shall be capable of applying skip or solid lines in any sequence, through any and all of the extrusion shoes, or the spray guns, and in programmable cycle lengths. In addition, the mobile unit shall be equipped with an automatic counting mechanism capable of recording the number of lineal feet of thermoplastic markings applied to the pavement surface with an accuracy of 0.5 percent.

1.5.3.5 Portable Application Equipment

The portable applicator shall be defined as hand-operated equipment, specifically designed for placing special markings such as crosswalks, stopbars, legends, arrows, and short lengths of lane, edge and centerlines. The portable applicator shall be capable of applying thermoplastic pavement markings by the extrusion method. The portable applicator shall be loaded with hot thermoplastic composition from the melting kettles on the mobile applicator. The portable applicator shall be equipped with all the necessary components, including a materials storage reservoir, bead dispenser, extrusion shoe, and heating accessories, so as to be capable of holding the molten thermoplastic at a temperature of 375 to 425 degrees F, of extruding a line of 3 to 12 inches in width, and in thickness of not less than 0.120 inch nor more than 0.190 inch and of generally uniform cross section.

1.5.4 Reflective Media Dispenser

The dispenser for applying the reflective media shall be attached to the paint dispenser and shall operate automatically and simultaneously with the applicator through the same control mechanism. The dispenser shall be capable of adjustment and designed to provide uniform flow of reflective media over the full length and width of the stripe at the rate of coverage specified in paragraph APPLICATION, at all operating speeds of the applicator to which it is attached.

1.5.5 Preformed Tape Application Equipment

Mechanical application equipment shall be used for the placement of preformed marking tape. Mechanical application equipment shall be defined as a mobile pavement marking machine specifically designed for use in applying precoated, pressure-sensitive pavement marking tape of varying widths, up to 12 inches. The applicator shall be equipped with rollers, or other suitable compactive device, to provide initial adhesion of the preformed, pressure-sensitive marking tape with the pavement surface. Additional hand-operated rollers shall be used as required to properly seat the thermoplastic tape.

1.5.6 Surface Preparation Equipment

1.5.6.1 Sandblasting Equipment

Sandblasting equipment shall include an air compressor, hoses, and nozzles of proper size and capacity as required for cleaning surfaces to be painted. The compressor shall be capable of furnishing not less than 150 cfm of air at a pressure of not less than 90 psi at each nozzle used, and shall be equipped with traps that will maintain the compressed air free of oil and water.

1.5.6.2 Waterblast Equipment

The water pressure shall be specified at 2600 psi at 140 degrees F in order

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to adequately clean the surfaces to be marked. Water will be furnished at no cost to the Contractor from a fire hydrant designated by the Contracting Officer or authorized representative and located within a reasonable proximity to the work area. The Contractor shall install a gate valve and a back-flow prevention device on the fire hydrant tap. The Contractor shall furnish all equipment, material, and labor required to obtain and deliver water from the designated fire hydrant to the work area(s).

1.5.7 Marking Removal Equipment

Equipment shall be mounted on rubber tires and shall be capable of removing markings from the pavement without damaging the pavement surface or joint sealant. Waterblasting equipment shall be capable of producing an adjustable, pressurized stream of water. Sandblasting equipment shall include an air compressor, hoses, and nozzles. The compressor shall be equipped with traps to maintain the air free of oil and water.

1.5.7.1 Shotblasting Equipment

Shotblasting equipment shall be capable of producing an adjustable depth of removal of marking and pavement. Each unit shall be self-cleaning and self-contained, shall be able to confine dust and debris from the operation, and shall be capable of recycling the abrasive for reuse.

1.5.7.2 Chemical Equipment

Chemical equipment shall be capable of application and removal of chemicals from the pavement surface, and shall leave only non-toxic biodegradable residue.

1.5.8 Traffic Controls

Suitable warning signs shall be placed near the beginning of the worksite and well ahead of the worksite for alerting approaching traffic from both directions. Small markers shall be placed along newly painted lines or freshly placed raised markers to control traffic and prevent damage to newly painted surfaces or displacement of raised pavement markers. Painting equipment shall be marked with large warning signs indicating slow-moving painting equipment in operation.

1.6 MAINTENANCE OF TRAFFIC

1.6.1 Lighting

When night operations are necessary, all necessary lighting and equipment shall be provided. Lighting shall be directed or shaded to prevent interference with aircraft, the air traffic control tower, and other base operations. All lighting and related equipment shall be capable of being removed from the runway within 15 minutes of notification of an emergency. Night work must be coordinated with the Airfield Manager and approved in advance by the Contracting Officer or authorized representative. The Government reserves the right to accept or reject night work on the day following night activities by the Contractor.

1.6.2 Roads, Streets, and Parking Areas

When traffic must be rerouted or controlled to accomplish the work, the necessary warning signs, flagpersons, and related equipment for the safe passage of vehicles shall be provided.

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1.7 WEATHER LIMITATIONS FOR REMOVAL

Pavement surface shall be free of snow, ice, or slush. Surface temperature shall be at least 40 degrees F and rising at the beginning of operations, except those involving shot or sand blasting. Operation shall cease during thunderstorms. Operation shall cease during rainfall, except for waterblasting and removal of previously applied chemicals. Waterblasting shall cease where surface water accumulation alters the effectiveness of material removal.

1.8 QUALIFICATIONS

The Contractor shall submit documentation certifying that pertinent personnel are qualified for equipment operation and handling of chemicals.

PART 2 PRODUCTS

2.1 MATERIALS

Provide materials conforming to the requirements specified herein.

2.1.1 Paints for Roads and Streets

FS TT-P-1952 High Build Acrylic Coating (HBAC), color as selected.

2.1.2 Reflective Media for Roads and Streets

FS TT-B-1325, Type I, Gradation A.

2.1.3 Thermoplastic Compound

The thermoplastic reflectorized pavement marking compound shall be extruded or sprayed in a molten state onto a primed pavement surface. Following a surface application of glass beads and upon cooling to normal pavement temperatures, the marking shall be an adherent reflectorized strip of the specified thickness and width that is capable of resisting deformation by traffic.

2.1.3.1 Composition Requirements

The binder component shall be formulated as a hydrocarbon resin. The pigment, beads and filler shall be uniformly dispersed in the binder resin. The thermoplastic composition shall be free from all skins, dirt, and foreign objects and shall comply with the following requirements:

<u>Component</u>	<u>Percent by Weight</u>	
	<u>White</u>	<u>Yellow</u>
Binder	17 min	17 min
Titanium dioxide	10 min	-
Glass beads	20 min	20 min
Calcium carbonate and inert fillers	49 min	*
Yellow pigments	-	*

*Amount and type of yellow pigment, calcium carbonate and inert fillers shall be at the option of the manufacturer, providing the other composition requirements of this specification are met.

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2.1.3.2 Physical Properties

- a. Drying time: When installed at 70 degrees F and in thicknesses between 0.120 and 0.190 inch, the composition shall be completely solid and shall show no damaging effect from traffic after curing 15 minutes.
- b. Softening point: The composition shall have a softening point of not less than 194 degrees F when tested in accordance with ASTM E 28.
- c. Specific gravity: The specific gravity of the composition shall be between 1.9 and 2.2 as determined in accordance with ASTM D 792.

2.1.3.3 Primer

- a. Asphalt concrete primer: The primer for asphalt concrete pavements shall be a thermosetting adhesive with a solids content of pigment reinforced synthetic rubber and synthetic plastic resin dissolved or dispersed in a volatile organic solvent. The solids content shall not be less than 10 percent by weight at 70 degrees F and 60 percent relative humidity. A wet film thickness of 0.005 inch, plus or minus 0.001 inch, shall dry to a tack-free condition in less than 5 minutes.
- b. Portland cement concrete primer: The primer for portland cement concrete pavements shall be an epoxy resin primer. The primer shall be of the type recommended by the manufacturer of the thermoplastic composition.

2.1.4 PREFORMED TAPE

The preformed tape shall be an adherent reflectorized strip in accordance with ASTM D 4505 Type I or IV, Class optional.

2.1.5 Raised Pavement Markers

Either metallic or nonmetallic markers of the button or prismatic reflector type may be used. Markers shall be of permanent colors as specified for pavement marking, and shall retain the color and brightness under the action of traffic. Button markers shall have a diameter of not less than 4 inches, and shall be spaced not more than 40 feet apart on solid longitudinal lines. Broken centerline marker spacings shall be in segments of 3 with gaps 3 of 9 between segments. Button markers shall have rounded surfaces presenting a smooth contour to traffic and shall not project more than 3/4 inch above level of pavement. Pavement markers and adhesive epoxy shall conform to ASTM D 4280

2.1.6 High Build Acrylic Coating (HBAC)

Formulate High Build Acrylic Coating (HBAC) to meet the requirements of Table I.

2.1.6.1 Preapproved HBAC Vendors and Materials

Table II presents a partial list of HBAC vendors and materials. Up to specifications's date of issue, preapproved materials met specification requirements. It is the user's responsibility to confirm preapproved material formulations have not changed and specification requirements will

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be met. Other products may meet HBAC requirements.

PART 3 EXECUTION

3.1 SURFACE PREPARATION

Allow new pavement surfaces to cure for a period of not less than 30 days before application of marking materials. Thoroughly clean surfaces to be marked before application of the paint. Remove dust, dirt, and other granular surface deposits by sweeping, blowing with compressed air, rinsing with water, or a combination of these methods as required. Remove rubber deposits, existing paint markings, residual curing compounds, and other coatings adhering to the pavement by water blasting. For Portland Cement Concrete pavement, grinding, light shot blasting, and light scarification, to a resulting profile equal to **ICRI 03732** CSP 2, CSP 3, and CSP 4, respectively, can be used in addition to water blasting, to either remove existing coatings or for surface preparation on most pavements: shot blasting shall not be used on airfield pavements due to the potential of Foreign Object Damage (FOD) to aircraft. Scrub affected areas, where oil or grease is present on old pavements to be marked, with several applications of trisodium phosphate solution or other approved detergent or degreaser and rinse thoroughly after each application. After cleaning oil-soaked areas, seal with shellac or primer recommended by the manufacturer to prevent bleeding through the new paint. Do not commence painting in any area until pavement surfaces are dry and clean.

3.2 APPLICATION

3.2.1 Testing for Moisture

Apply pavement markings to dry pavement only. The Contractor shall test the pavement surface for moisture before beginning work after each period of rainfall, fog, high humidity, or cleaning, or when the ambient temperature has fallen below the dew point. Do not commence marking until the pavement is sufficiently dry and the pavement condition has been approved by the CO or authorized representative. Employ the "plastic wrap method" to test the pavement for moisture as follows: Cover the pavement with a 300 mm by 300 mm (12 inch by 12 inch) section of clear plastic wrap and seal the edges with tape. After 15 minutes, examine the plastic wrap for any visible moisture accumulation inside the plastic. Do not begin marking operations until the test can be performed with no visible moisture accumulation inside the plastic wrap.

3.2.2 Rate of Application

3.2.2.1 Reflective Markings

Apply paint evenly to the pavement area to be coated at a rate of **105 plus or minus 5 square feet per gallon**. Apply High Build Acrylic Coating (HBAC) at a rate of **50 square feet per gallon**. Collect and record readings for white and yellow retroreflective markings at the rate of one reading per **1000 linear feet**. The minimum acceptable average for white markings is 200 millicandelas per square meter per lux (mcd/m²/lx) (measured with Mirolux 12 Retroreflectometer or similar instrument as agreed). The minimum acceptable average for yellow markings is 175 millicandelas per square meter per lux (mcd/m²/lx). Readings shall be computed by averaging a minimum of 10 readings taken within the area at random locations. Areas not meeting the retroreflective requirements stated above shall be re-marked.

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3.2.2.2 Nonreflective Markings

Apply paint evenly to the pavement surface to be coated at a rate of 105 plus or minus 5 square feet per gallon. Apply High Build Acrylic Coating (HBAC) at a rate of 50 square feet per gallon.

3.2.2.3 Thermoplastic Compound

After surface preparation has been completed, prime the asphalt or concrete pavement surface with spray equipment. Allow primer materials to "set-up" prior to applying the thermoplastic composition. Allow the asphalt concrete primer to dry to a tack-free condition, usually occurring in less than 10 minutes. Allow the Portland Cement concrete primer to dry in accordance with the thermoplastic manufacturer recommendations. To shorten the curing time of the epoxy resins, an infrared heating device may be used on the concrete primer. Apply asphalt concrete primer to all asphalt concrete pavements at a wet film thickness of 0.005 inch, plus or minus 0.001 inch 265 to 400 square feet per gallon. Apply portland cement concrete primer to all concrete pavements (including concrete bridge decks) at a wet film thickness of between 0.04 to 0.05 inch 320 to 400 square feet per gallon. After the primer has "set-up", apply the thermoplastic at temperatures no lower than 375 degrees F nor higher than 425 degrees F at the point of deposition. Immediately after installation of the marking, apply drop-on reflective glass spheres mechanically at the rate of one pound per 20 square feet such that the spheres are held by and imbedded in the surface of the molten material. Apply all extruded thermoplastic markings at the specified width and at a thickness of not less than 0.125 inch nor more than 0.190 inch. Apply all sprayed thermoplastic markings at the specified width and the thickness designated in the contract plans. If the plans do not specify a thickness, apply centerline markings at a wet thickness of 0.090 inch, plus or minus 0.005 inch, and edgeline markings at a wet thickness of 0.060 inch, plus or minus 0.005 inch.

3.2.3 Painting

Apply paint pneumatically with approved equipment at rate of coverage specified herein. Provide guidelines and templates as necessary to control paint application. Take special precautions in marking numbers, letters, and symbols. Manually paint numbers, letters, and symbols. Sharply outline all edges of markings. The maximum drying time requirements of the paint specifications will be strictly enforced, to prevent undue softening of bitumen, and pickup, displacement, or discoloration by tires of traffic. Discontinue painting operations if there is a deficiency in drying of the markings until cause of the slow drying is determined and corrected.

3.2.4 Reflective Media

Application of reflective media shall immediately follow the application of paint. Accomplish drop-on application of the glass spheres to ensure even distribution at the specified rate of coverage. Should there be malfunction of either paint applicator or reflective media dispenser, discontinue operations until deficiency is corrected.

3.2.5 Thermoplastic Compound

Place thermoplastic pavement markings upon dry pavement. At the time of installation the pavement surface temperature shall be a minimum of 40 degrees F and rising. Thermoplastics, as placed, shall be free from dirt

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or tint. Apply all centerline, skipline, edgeline, and other longitudinal type markings with a mobile applicator. Place all special markings, crosswalks, stop bars, legends, arrows, and similar patterns with a portable applicator, using the extrusion method.

3.2.6 Raised Pavement Markers

Prefabricated markers shall be aligned carefully at the required spacing or as directed and permanently fixed in place by means of epoxy adhesives. To ensure good bond, areas where markers will be set shall be thoroughly cleaned by water blasting and use of compressed air prior to applying adhesive.

3.3 FIELD TESTING, INSPECTION, AND DEMONSTRATIONS

3.3.1 Sampling and Testing

As soon as the paint reflective and thermoplastic materials are available for sampling, obtain by random selection from the sealed containers, two quart samples of each batch in the presence of the Contracting Officer. Accomplish adequate mixing prior to sampling to ensure a uniform, representative sample. A batch is defined as that quantity of material processed by the manufacturer at one time and identified by number on the label. Clearly identify samples by designated name, specification number, batch number, project contract number, intended use, and quantity involved.

3.3.2 Inspection

Examine material at the job site to determine that it is the material referenced in the report of test results or certificate of compliance. A certificate of compliance shall be accompanied by test results substantiating conformance to the specified requirements.

3.3.3 Surface Preparations and Application Procedures

Surface preparations and application procedures will be examined by the Contracting Officer to determine conformance with the requirements specified. Approve each separate operation prior to initiation of subsequent operations.

3.4 TRAFFIC CONTROL AND PROTECTION

Place warning signs near the beginning of the work site and well ahead of the work site for alerting approaching traffic from both directions. Place small markers along newly painted lines to control traffic and prevent damage to newly painted surfaces. Mark painting equipment with large warning signs indicating slow-moving painting equipment in operation. Do not use foil-backed material for temporary pavement marking because of its potential to conduct electricity during accidents involving downed power lines.

3.5 QUALITY ASSURANCE

Demonstrate success of bond of reflective media, new paint marking and the pavement surface, vacuum cured surface of new marking after a seven (7) day dry time. Inspect newly applied markings for signs of bond failure based on visual inspection and comparison to results from Test Stripe Demonstration paragraph.

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3.5.1 Reflective Media and Coating Bond Verification

Within seven (7) days after pavement marking application, use industrial vacuum to sweep new markings. Visually inspect the pavement markings and the material captured by the vacuum. Verify that no significant loss of reflective media has occurred to the pavement marking due to the vacuum cleaning.

3.5.2 Reflective Media and Coating Application Verification

Use a wet film thickness gauge to measure the application of wet paint.

Use a microscope or magnifying glass to evaluate the embedment of glass beads in the paint. Verify the glass bead embedment with approximately 50% of the beads embedded and 50% of the beads exposed.

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TABLE I
REQUIREMENTS FOR HIGH BUILD ACRYLIC COATINGS (HBAC)

Test	Minimum Requirement (and Maximum where indicated)
Resin System (ASTM D 2621)	Waterborne 100% Acrylic
Percent Volume Solids (ASTM D 2697)	58%
Volatile Organic Compound, max. (ASTM D 3960)	1.25 lbs/gal
White (FED-STD-595)	37925
Yellow (FED-STD-595)	33538
Shore D Hardness (ASTM D 2240)	45
1/8 inch Mandrel Bend @ 5 mils Dry Film Thickness (DFT, one-week cure (ASTM D 522, Method B)	No visual defects at bend (Conditions @ ASTM D 3924)
Adhesion to Concrete and Asphaltic Pavements (ASTM D 4541)	140 psi or 100% cohesive failure in pavement
Accelerated Weathering, Yellow, 2500 Hours UV Exposure (ASTM G 53: see note 1)	Max. color loss to 33655 (FED-STD-595)
Water Absorption @ 168 Hours Immersion Tap Water (ASTM D 471)	9.0% max. weight increase (conditions @ ASTM D 3924)
Application @ 65 mils Wet, One Coat, One-week Cure, (see note 2)	No visual cracking or curling (conditions @ ASTM D 3924)
No Pick-Up @ 25 mils (ASTM D 711)	Wet 10 minutes max.
Lead (ASTM D 3335)	0.06% max.
Cadmium (ASTM D 3335)	0.06% max.
Chromium (ASTM D 3718)	0.00%

Notes:

(1) Properly mix and apply yellow paint at 10 mils +/- 2 mils DFT over a suitably sized, clean aluminum substrate (ASTM D 823), and cure for a minimum of 48 hours: four individual yellow samples shall be prepared. Expose three samples to continuous Ultraviolet (UV) light for 2500 hours, without cycles condensation, in accordance to ASTM G 53: UVA-340 lamps shall be used in the testing apparatus. Following exposure, compare the three exposed samples to the "one" non-exposed sample using FED-STD-595 colors 33538 and 33655 as visual references: evaluate exposed samples for degree of visual color loss. Yellow paint shall receive a passing rating if each exposed sample appears equivalent to the non-exposed sample, and in addition,

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TABLE I

REQUIREMENTS FOR HIGH BUILD ACRYLIC COATINGS (HBAC)

displays color loss no greater than FED-STD-595 color 33655.

(2) Using double-stick, foam mounting tape (or equal) with a nominal thickness of 65 mils, apply a rectangular mold with inner dimensions of 3 in by 10 in to a clean aluminum sample approximately sized at 6 in by 12 in by 1/8 in. Do not remove the tape's plastic backing. Mix and apply excess paint into mold. Remove excess paint, by squeegee or other appropriate draw down technique, to a uniform thickness equal to the tape's height. Paint application and draw down shall be performed within a period of no more than 60 seconds. Approximately one to two minutes following the draw down, remove tape from sample and allow coating to cure for a minimum period of one week ASTM D 3924. Using a micrometer or other appropriate device, measure cured coating thickness (less sample thickness) to confirm resulting coating application was at or above 38 mils DFT. Inspect coating for visual signs of cracking and curling. Following a one week cure, coating shall receive a passing rating if applied greater than 38 mils DFT and visually free of both cracking and curling.

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GRC Main Gate Security Project - Phase 1

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TABLE II
PREAPPROVED HBACs

Manufacturer	Products
TMT-Pathway 1021 N. Mission Road Los Angeles, CA 90033 (800) 338-7680	Legend Build, #2712A9, White Legend Build, #2713A9, Yellow
Pervo Paints 6624 Stanford Ave. Los Angeles, CA 90001 (323) 758-1147	Pervo 6050, White Pervo 6053, Yellow
Vogel Traffic Services 1920 Albany Place South PO Box 140 Orange City, IA 51041 (712) 737-4016	UC-1516, White UC-3588, Yellow

-- End of Section --

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SECTION 33 11 00

WATER DISTRIBUTION

10/06

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA B300	(2004) Hypochlorites
AWWA B301	(2004) Liquid Chlorine
AWWA C111/A21.11	(2000) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C500	(2002; R 2003) Metal-Seated Gate Valves for Water Supply Service
AWWA C600	(2005) Installation of Ductile-Iron Water Mains and Their Appurtenances
AWWA C651	(2005; Errata 2005) Standard for Disinfecting Water Mains

ASTM INTERNATIONAL (ASTM)

ASTM C 94/C 94M	(2007) Standard Specification for Ready-Mixed Concrete
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MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-80	(2003) Bronze Gate, Globe, Angle and Check Valves
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UNDERWRITERS LABORATORIES (UL)

UL 262	(2004) Standard for Gate Valves for Fire-Protection Service
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1.2 DESIGN REQUIREMENTS

1.2.1 Water Service Lines

Provide water service lines indicated as 4 inch 100 mm lines from water distribution main to building service at a point approximately 5 feet 1.5 m from building. Water service lines shall be Ductile-iron pipe, and valves as specified for water mains may also be used for service lines. Provide water service line appurtenances as specified.

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1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Piping Materials

Water service line piping, fittings, joints, valves, and coupling

indicator post

valve box

Submit manufacturer's standard drawings or catalog cuts, except submit both drawings and cuts for push-on and rubber-gasketed bell-and-spigot joints. Include information concerning gaskets with submittal for joints and couplings.

SD-06 Test Reports

Bacteriological Disinfection;

Test results from commercial laboratory verifying disinfection

SD-07 Certificates

SD-08 Manufacturer's Instructions

Delivery, storage, and handling

Installation procedures for water piping

1.4 DELIVERY, STORAGE, AND HANDLING

1.4.1 Delivery and Storage

Inspect materials delivered to site for damage. Unload and store with minimum handling. Store materials on site in enclosures or under protective covering. Store plastic piping, jointing materials and rubber gaskets under cover out of direct sunlight. Do not store materials directly on the ground. Keep inside of pipes, fittings, valves free of dirt and debris.

1.4.2 Handling

Handle pipe, fittings, valves, hydrants, and other accessories in a manner to ensure delivery to the trench in sound undamaged condition. Take special care to avoid injury to coatings and linings on pipe and fittings; make repairs if coatings or linings are damaged. Do not place any other material or pipe inside a pipe or fitting after the coating has been

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applied. Carry, do not drag pipe to the trench. Use of pinch bars and tongs for aligning or turning pipe will be permitted only on the bare ends of the pipe. The interior of pipe and accessories shall be thoroughly cleaned of foreign matter before being lowered into the trench and shall be kept clean during laying operations by plugging or other approved method. Before installation, the pipe shall be inspected for defects. Material found to be defective before or after laying shall be replaced with sound material without additional expense to the Government. Store rubber gaskets that are not to be installed immediately, under cover out of direct sunlight.

PART 2 PRODUCTS

2.1 WATER DISTRIBUTION MAIN MATERIALS

2.1.1 Piping Materials

2.1.1.1 Ductile-Iron Piping

a. Pipe and Fittings: Pipe, except flanged pipe, AWWA C151/A21.51. Pressure Class 250 Thickness Class 50. Flanged pipe, AWWA C115/A21.15. Fittings, AWWA C110/A21.10 or AWWA C153/A21.53 fittings with push-on joint ends conforming to the same requirements as fittings with mechanical-joint ends, except that the bell design shall be modified, as approved, for push-on joint. Fittings shall have pressure rating at least equivalent to that of the pipe. Ends of pipe and fittings shall be suitable for the specified joints. Pipe and fittings shall have cement-mortar lining, AWWA C104/A21.4, standard thickness.

b. Joints and Jointing Materials:

(1) Joints: Joints for pipe and fittings shall be push-on joints or mechanical joints.

(2) Push-On Joints: Shape of pipe ends and fittings ends, gaskets, and lubricant for joint assembly, AWWA C111/A21.11.

(3) Mechanical Joints: Dimensional and material requirements for pipe ends, glands, bolts and nuts, and gaskets, AWWA C111/A21.11.

(4) Flanged Joints: Bolts, nuts, and gaskets for flanged connections as recommended in the Appendix to AWWA C115/A21.15. Flange for the setscrewed flanges shall be of ductile iron, ASTM A 536, Grade 65-45-12, and conform to the applicable requirements of ASME B16.1, Class 250. Setscrews for setscrewed flanges shall be 1310 MPa 190,000 psi tensile strength, heat treated and zinc-coated steel. Gasket and lubricants for setscrewed flanges, in accordance with applicable requirements for mechanical-joint gaskets specified in AWWA C111/A21.11. Design of setscrewed gasket shall provide for confinement and compression of gasket when joint to adjoining flange is made.

2.2 WATER SERVICE LINE MATERIALS

2.2.1 Piping Materials

2.2.1.1 Ductile-Iron Piping

Comply with "Ductile-Iron Piping" subparagraph under paragraph "Water Distribution Main Materials."

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2.2.1.2 Insulating Joints

Joints between pipe of dissimilar metals shall have a rubber-gasketed or other suitable approved type of insulating joint or dielectric coupling which will effectively prevent metal-to-metal contact between adjacent sections of piping.

2.2.2 Water Service Line Appurtenances

2.2.2.1 Gate Valves 3 Inch Size and Larger on Buried Piping

Gate valves 3 inch size and larger on buried piping AWWA C500 or UL 262 and of one manufacturer. Valves, AWWA C500, nonrising stem type with double-disc gates. Valves, UL 262, inside-screw type with operating nut, split wedge or double disc type gate, and designed for a hydraulic working pressure of 175 psi. Materials for UL 262 valves conforming to the reference standards specified in AWWA C500. Valves shall open by counterclockwise rotation of the valve stem. Stuffing boxes shall have O-ring stem seals and shall be bolted and constructed so as to permit easy removal of parts for repair. Valves on 4 inch service lines shall have ends suitable for joining to the pipe used; push-on joint ends or mechanical-joint ends for joining to ductile-iron pipe. Valve in fire service shall have telescoping barrel indicator post, cast iron, UL and FM approved - red color.

2.2.2.2 Gate Valves Smaller than 3 Inch in Size on Buried Piping

Gate valves smaller than 3 inch size on Buried Piping MSS SP-80, Class 150, solid wedge, nonrising stem. Valves shall have flanged or threaded end connections, with a union on one side of the valve. Provide valve box as shown on drawings.

2.2.2.3 Tapping Sleeves

Tapping sleeves of the sizes indicated for connection to existing main shall be the cast gray, ductile, or malleable iron, split-sleeve type with flanged or grooved outlet, and with bolts, follower rings and gaskets on each end of the sleeve. Construction shall be suitable for a maximum working pressure of 200 psi. Bolts shall have square heads and hexagonal nuts. Longitudinal gaskets and mechanical joints with gaskets shall be as recommended by the manufacturer of the sleeve. When using grooved mechanical tee, it shall consist of an upper housing with full locating collar for rigid positioning which engages a machine-cut hole in pipe, encasing an elastomeric gasket which conforms to the pipe outside diameter around the hole and a lower housing with positioning lugs, secured together during assembly by nuts and bolts as specified, pretorqued to 50 foot-pound.

2.2.2.4 Disinfection

Chlorinating materials shall conform to the following:

Chlorine, Liquid: AWWA B301.

Hypochlorite, Calcium and Sodium: AWWA B300.

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PART 3 EXECUTION

3.1 INSTALLATION OF PIPELINES

3.1.1 General Requirements for Installation of Pipelines

These requirements shall apply to all pipeline [installation](#) except where specific exception is made in the "Special Requirements..." paragraphs.

3.1.1.1 Location of Water Lines

Terminate the work covered by this section at a point approximately [1.5 m](#) from the building. Where the location of the water line is not clearly defined by dimensions on the drawings, do not lay water line closer horizontally than [3.0 m](#) from any sewer line. Where water lines cross under gravity sewer lines, encase sewer line fully in concrete for a distance of at least [3.0 m](#) on each side of the crossing. Lay water lines which cross sewer force mains and inverted siphons at least [600 mm](#) above these sewer lines; when joints in the sewer line are closer than [900 mm](#) horizontally from the water line, encase these joints in concrete. Do not lay water lines in the same trench with gas lines or electric wiring.

3.1.1.2 Earthwork

Perform earthwork operations in accordance with Division 31.

3.1.1.3 Pipe Laying and Jointing

Remove fins and burrs from pipe and fittings. Before placing in position, clean pipe, fittings, valves, and accessories, and maintain in a clean condition. Provide proper facilities for lowering sections of pipe into trenches. Do not under any circumstances drop or dump pipe, fittings, valves, or any other water line material into trenches. Cut pipe in a neat workmanlike manner accurately to length established at the site and work into place without springing or forcing. Replace by one of the proper length any pipe or fitting that does not allow sufficient space for proper installation of jointing material. Blocking or wedging between bells and spigots will not be permitted. Lay bell-and-spigot pipe with the bell end pointing in the direction of laying. Grade the pipeline in straight lines; avoid the formation of dips and low points. Support pipe at proper elevation and grade. Secure firm, uniform support. Wood support blocking will not be permitted. Lay pipe so that the full length of each section of pipe and each fitting will rest solidly on the pipe bedding; excavate recesses to accommodate bells, joints, and couplings. Provide anchors and supports where necessary for fastening work into place. Make proper provision for expansion and contraction of pipelines. Keep trenches free of water until joints have been properly made. At the end of each work day, close open ends of pipe temporarily with wood blocks or bulkheads. Do not lay pipe when conditions of trench or weather prevent installation. Depth of cover over top of pipe shall not be less than [2 760 mm](#).

3.1.1.4 Installation of Tracer Wire

Install a continuous length of tracer wire for the full length of each run of nonmetallic pipe. Attach wire to top of pipe in such manner that it will not be displaced during construction operations.

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3.1.1.5 Connections to Existing Water Lines

Make connections to existing water lines after approval is obtained and with a minimum interruption of service on the existing line. Make connections to existing lines under pressure in accordance with the recommended procedures of the manufacturer of the pipe being tapped.

3.1.1.6 Flanged Pipe

Flanged pipe shall only be installed above ground or with the flanges in valve pits.

3.1.2 Special Requirements for Installation of Water Mains

3.1.2.1 Installation of Ductile-Iron Piping

Unless otherwise specified, install pipe and fittings in accordance with paragraph entitled "General Requirements for Installation of Pipelines" and with the requirements of AWWA C600 for pipe installation, joint assembly, valve-and-fitting installation, and thrust restraint.

- a. Jointing: Make push-on joints with the gaskets and lubricant specified for this type joint; assemble in accordance with the applicable requirements of AWWA C600 for joint assembly. Make mechanical joints with the gaskets, glands, bolts, and nuts specified for this type joint; assemble in accordance with the applicable requirements of AWWA C600 for joint assembly and the recommendations of Appendix A to AWWA C111/A21.11. Make flanged joints with the gaskets, bolts, and nuts specified for this type joint. Make flanged joints up tight; avoid undue strain on flanges, fittings, valves, and other equipment and accessories. Align bolt holes for each flanged joint. Use full size bolts for the bolt holes; use of undersized bolts to make up for misalignment of bolt holes or for any other purpose will not be permitted. Do not allow adjoining flange faces to be out of parallel to such degree that the flanged joint cannot be made watertight without overstraining the flange. When flanged pipe or fitting has dimensions that do not allow the making of a proper flanged joint as specified, replace it by one of proper dimensions. Use setscrewed flanges to make flanged joints where conditions prevent the use of full-length flanged pipe and assemble in accordance with the recommendations of the setscrewed flange manufacturer. Assemble joints made with sleeve-type mechanical couplings in accordance with the recommendations of the coupling manufacturer.
- b. Allowable Deflection: The maximum allowable deflection shall be as given in AWWA C600. If the alignment requires deflection in excess of the above limitations, special bends or a sufficient number of shorter lengths of pipe shall be furnished to provide angular deflections within the limit set forth.
- c. Pipe Anchorage: Provide concrete thrust blocks reaction backing for pipe anchorage, except where metal harness is indicated. Thrust blocks shall be in accordance with the requirements of AWWA C600 for thrust restraint, except that size and positioning of thrust blocks shall be as indicated. Use concrete, ASTM C 94/C 94M, having a minimum compressive strength of 2,500 psi at 28 days; or use concrete of a mix not leaner than one part

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cement, 2 1/2 parts sand, and 5 parts gravel, having the same minimum compressive strength.

3.1.3 Disinfection

Prior to disinfection, obtain Contracting Officer approval of the proposed method for disposal of waste water from disinfection procedures. Disinfect new water piping and existing water piping affected by Contractor's operations in accordance with [AWWA C651](#). Fill piping systems with solution containing minimum of 50 parts per million of available chlorine and allow solution to stand for minimum of 24 hours. Flush solution from the systems with domestic water until maximum residual chlorine content is within the range of 0.2 and 0.5 parts per million, or the residual chlorine content of domestic water supply. Obtain at least two consecutive satisfactory bacteriological samples from new water piping, analyze by a certified laboratory, and submit the results prior to the new water piping being placed into service. Disinfection of systems supplying nonpotable water is not required.

3.2 FIELD QUALITY CONTROL

3.2.1 Field Tests and Inspections

Prior to hydrostatic testing, obtain Contracting Officer approval of the proposed method for disposal of waste water from hydrostatic testing. The Contracting Officer will conduct field inspections and witness field tests specified in this section. The Contractor shall perform field tests, and provide labor, equipment, and incidentals required for testing, except that water and electric power needed for field tests will be furnished as set forth in Division 1. The Contractor shall produce evidence, when required, that any item of work has been constructed in accordance with the drawings and specifications. Do not begin testing on any section of a pipeline where concrete thrust blocks have been provided until at least 5 days after placing of the concrete.

3.2.2 Testing Procedure

Test water mains and water service lines in accordance with the applicable specified standard, except for the special testing requirements given in paragraph entitled "Special Testing Requirements." Test ductile-iron water mains and water service lines in accordance with the requirements of [AWWA C600](#) for hydrostatic testing. The amount of leakage on ductile-iron pipelines with mechanical-joints or push-on joints shall not exceed the amounts given in [AWWA C600](#); no leakage will be allowed at joints made by any other method.

3.2.3 Special Testing Requirements

For pressure test, use a hydrostatic pressure [50 psi](#) greater than the maximum working pressure of the system, except that for those portions of the system having pipe size larger than [2 inches](#) in diameter, hydrostatic test pressure shall be not less than [200 psi](#). Hold this pressure for not less than 2 hours. Prior to the pressure test, fill that portion of the pipeline being tested with water for a soaking period of not less than 24 hours. For leakage test, use a hydrostatic pressure not less than the maximum working pressure of the system. Leakage test may be performed at the same time and at the same test pressure as the pressure test.

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3.3 CLEANUP

Upon completion of the installation of water lines, and appurtenances, all debris and surplus materials resulting from the work shall be removed.

-- End of Section --

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SECTION 33 30 00

SANITARY SEWERS

04/08

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C 270 (2007a) Standard Specification for Mortar for Unit Masonry

ASTM C 969 (2002) Standard Practice for Infiltration and Exfiltration Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines (Metric)

ASTM D 2321 (2005) Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications

ASTM D 3212 (2007) Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals

ASTM F 477 (2007) Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe

UNI-BELL PVC PIPE ASSOCIATION (UBPPA)

UBPPA UNI-B-6 (1998) Recommended Practice for Low-Pressure Air Testing of Installed Sewer Pipe

1.2 SYSTEM DESCRIPTION

1.2.1 Sanitary Sewer Gravity Pipeline

Provide mains and laterals 6 inch line of polyvinyl chloride (PVC) plastic pipe, ASTM D 3034, SDR26. Make provisions for future building connection with 6 inch line of polyvinyl chloride (PVC) plastic pipe. Modify existing exterior sanitary gravity sewer manhole. Provide system complete and ready for future extension and operation. The exterior sanitary gravity sewer system includes equipment, materials, installation, and workmanship as specified herein more than 5 feet outside of building walls.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control

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approval. Submit the following in accordance with Section 01 33 00
SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Existing Conditions

Drawings of existing conditions, as specified.

SD-02 Shop Drawings

Drawings

Installation and As-Built drawings, as specified, including existing concrete manhole, as modified for drop connection.

Details, as specified.

SD-03 Product Data

Pipeline materials

Submit manufacturer's standard drawings or catalog cuts.

SD-06 Test Reports

Test and inspection reports, as specified.

1.4 QUALITY ASSURANCE

1.4.1 Installer Qualifications

Install specified materials by a licensed underground utility Contractor licensed for such work in the state where the work is to be performed. Installing Contractor's License shall be current and be state certified or state registered.

1.4.2 Drawings

- a. Submit Installation Drawings showing complete detail, both plan and side view details with proper layout and elevations.
- b. Submit As-Built Drawings for the complete sanitary sewer system showing complete detail with all dimensions, both above and below grade, including invert elevation.
- c. Sign and seal As-Built Drawings by a Professional Surveyor and Mapper. Include the following statement: "All potable water lines crossed by sanitary hazard mains are in accordance with the permitted utility separation requirements."

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1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Delivery and Storage

1.5.1.1 Piping

Inspect materials delivered to site for damage; store with minimum of handling. Store materials on site in enclosures or under protective coverings. Store plastic piping and jointing materials and rubber gaskets under cover out of direct sunlight. Do not store materials directly on the ground. Keep inside of pipes and fittings free of dirt and debris.

1.5.2 Handling

Handle pipe, fittings, and other accessories in such manner as to ensure delivery to the trench in sound undamaged condition. Take special care not to damage linings of pipe and fittings. Carry, do not drag, pipe to trench.

1.6 PROJECT/SITE CONDITIONS

Submit drawings of [existing conditions](#), after a thorough inspection of the area in the presence of the Contracting Officer. Details shall include the environmental conditions of the site and adjacent areas. Submit copies of the records for verification before starting work.

PART 2 PRODUCTS

2.1 [PIPELINE MATERIALS](#)

Pipe shall conform to the respective specifications and other requirements specified below.

2.1.1 PVC Plastic Gravity Sewer Piping

2.1.1.1 PVC Plastic Gravity Pipe and Fittings

ASTM D 3034, SDR 26, size 6 inch (150) with fittings as required.

2.1.1.2 PVC Plastic Gravity Joints and Jointing Material

Joints shall conform to [ASTM D 3212](#). Gaskets shall conform to [ASTM F 477](#).

2.2 CONCRETE MATERIALS

2.2.1 Cement Mortar

Cement mortar shall conform to [ASTM C 270](#), Type M with Type II cement. Seal all penetrations at existing manholes watertight.

PART 3 EXECUTION

3.1 INSTALLATION OF PIPELINES AND APPURTENANT CONSTRUCTION

3.1.1 General Requirements for Installation of Pipelines

These general requirements apply except where specific exception is made in the following paragraphs entitled "Special Requirements."

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3.1.1.1 Location

The work covered by this section shall terminate at a point approximately 5 feet from the building. Where the location of the sewer is not clearly defined by dimensions on the drawings, do not lay sewer line closer horizontally than 10 feet to a water main or service line. Where sanitary sewer lines pass above water lines, encase sewer in concrete for a distance of 10 feet on each side of the crossing, or substitute rubber-gasketed pressure pipe for the pipe being used for the same distance. Where sanitary sewer lines pass below water lines, lay pipe so that no joint in the sewer line will be closer than 3 feet, horizontal distance, to the water line.

a. Sanitary piping installation parallel with water line:

- 1 Normal conditions: Sanitary piping or manholes shall be laid at least 10 feet horizontally from a water line whenever possible. The distance shall be measured edge-to-edge.

3.1.1.2 Pipe Laying and Jointing

Inspect each pipe and fitting before and after installation; replace those found defective and remove from site. Provide proper facilities for lowering sections of pipe into trenches. Lay nonpressure pipe with the bell ends in the upgrade direction. Adjust spigots in bells to give a uniform space all around. Blocking or wedging between bells and spigots will not be permitted. Replace by one of the proper dimensions, pipe or fittings that do not allow sufficient space for installation of joint material. At the end of each work day, close open ends of pipe temporarily with wood blocks or bulkheads. Provide batterboards not more than 25 feet apart in trenches for checking and ensuring that pipe invert elevations are as indicated. Laser beam method may be used in lieu of batterboards for the same purpose. Branch connections shall be made by use of regular fittings or solvent cemented saddles as approved.

3.1.1.3 Connections to Existing Lines

Obtain approval from the Contracting Officer before making connection to existing line. Conduct work so that there is minimum interruption of service on existing line.

3.1.2 Special Requirements

3.1.2.1 Installation of PVC Plastic Piping

Install pipe and fittings in accordance with paragraph entitled "General Requirements for Installation of Pipelines" of this section and with the requirements of ASTM D 2321 for laying and joining pipe and fittings. Make joints with the gaskets specified for joints with this piping and assemble in accordance with the requirements of ASTM D 2321 for assembly of joints. Make joints to other pipe materials in accordance with the recommendations of the plastic pipe manufacturer.

3.1.3 Miscellaneous Construction and Installation

3.1.3.1 Connecting to Existing Manholes

Pipe connections to existing manholes shall be made so that finish work

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will conform as nearly as practicable to the applicable requirements specified for new manholes, including all necessary concrete work, cutting, and shaping. The connection shall be centered on the manhole. Holes for the new pipe shall be of sufficient diameter to allow packing cement mortar around the entire periphery of the pipe but no larger than 1.5 times the diameter of the pipe. Cutting the manhole shall be done in a manner that will cause the least damage to the walls.

3.2 FIELD QUALITY CONTROL

3.2.1 Field Tests and Inspections

The Contracting Officer will conduct field inspections and witness field tests specified in this section. Perform field tests and provide labor, equipment, and incidentals required for testing. Be able to produce evidence, when required, that each item of work has been constructed in accordance with the drawings and specifications.

3.2.2 Tests for Nonpressure Lines

Check each straight run of pipeline for gross deficiencies by holding a light in a manhole; it shall show a practically full circle of light through the pipeline when viewed from the adjoining end of line.

3.2.2.1 Leakage Tests

Test lines for leakage by either infiltration tests or exfiltration tests, or by low-pressure air tests. Prior to testing for leakage, backfill trench up to at least lower half of pipe. When necessary to prevent pipeline movement during testing, place additional backfill around pipe sufficient to prevent movement, but leaving joints uncovered to permit inspection. When leakage or pressure drop exceeds the allowable amount specified, make satisfactory correction and retest pipeline section in the same manner. Correct visible leaks regardless of leakage test results.

a. Infiltration tests and exfiltration tests: Perform these tests for sewer lines made of the specified materials, not only concrete, in accordance with [ASTM C 969](#). Make calculations in accordance with the Appendix to [ASTM C 969](#).

b. Low-pressure air tests: Perform tests as follows:

1 PVC plastic pipelines: Test in accordance with [UBPPA UNI-B-6](#). Allowable pressure drop shall be as given in [UBPPA UNI-B-6](#). Make calculations in accordance with the Appendix to [UBPPA UNI-B-6](#).

c. Provide report of test results.

-- End of Section --

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SECTION 33 34 00

FORCE MAINS; SEWER 04/08

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C104/A21.4	(2003) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C110/A21.10	(2003) Ductile-Iron and Gray-Iron Fittings for Water
AWWA C111/A21.11	(2000) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C115/A21.15	(2005) Flanged Ductile-Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges
AWWA C151/A21.51	(2002; Errata 2002) Ductile-Iron Pipe, Centrifugally Cast, for Water
AWWA C500	(2002; R 2003) Metal-Seated Gate Valves for Water Supply Service
AWWA C508	(2001) Swing-Check Valves for Waterworks Service, 2 In. (50 mm) Through 24 In. (600 mm) NPS
AWWA C600	(2005) Installation of Ductile-Iron Water Mains and Their Appurtenances

ASME INTERNATIONAL (ASME)

ASME B16.1	(2005) Standard for Gray Iron Threaded Fittings; Classes 125 and 250
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ASTM INTERNATIONAL (ASTM)

ASTM C 478	(2007) Standard Specification for Precast Reinforced Concrete Manhole Sections
ASTM D 3308	(2006) PTFE Resin Skived Tape

DUCTILE IRON PIPE RESEARCH ASSOCIATION (DIPRA)

DIPRA TRD	(2002) Thrust Restraint Design for Ductile Iron Pipe
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1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-06 Test Reports

Hydrostatic Tests.

Copies of test results.

1.3 DELIVERY, STORAGE, AND HANDLING

Do not damage pipe, fittings and accessories, and pipe coatings during delivery, handling, and storage.

PART 2 PRODUCTS

2.1 PIPE AND FITTINGS

Piping for force mains 4 inches in diameter and larger shall be ductile iron. Piping 4 inches in diameter and larger inside pump stations shall be ductile iron pipe with bolted flange joints. Pipe shall conform to the respective specifications and other requirements specified below.

2.1.1 Ductile Iron Pipe

- a. Ductile Iron Pipe: AWWA C151/A21.51, working pressure not less than 150 psi, thickness Class 52.
- b. Fittings, Mechanical: AWWA C110/A21.10, rated for 150 psi.
- c. Fittings, Push-On: AWWA C110/A21.10 and AWWA C111/A21.11, rated for 150 psi.
- d. Lining: Pipe and fittings shall have cement mortar lining, AWWA C104/A21.4, standard thickness.

2.2 JOINTS

2.2.1 Ductile Iron Piping

- a. Push-on Joints: AWWA C111/A21.11, restrained.
- b. Mechanical Joints: AWWA C111/A21.11 as modified by AWWA C151/A21.51, restrained.
- c. Flanged Joints: AWWA C115/A21.15.

2.3 VALVES

2.3.1 Gate Valves

Gate valves 3 inches and larger shall comply with AWWA C500. Valves for buried service shall be non-rising stem (NRS), 2 inch square nut operated

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with joints applicable to the pipe or installation. Buried valves shall be furnished with extension stems comprising socket, extension stem and operating nut, and shall be of an appropriate length to bring operating nut to within 6 inches of grade. One 4 foot "T" handle valve wrench shall be furnished for each quantity of 6 buried valves. Gate valves that are exposed or installed inside shall be outside screw and yoke (OS&Y), handwheel operated with flange ends unless otherwise indicated. Gate valve operating nuts and handwheels shall have an arrow and the word "OPEN" cast in raised letters to indicate the direction of opening. Valves shall close in clockwise direction.

2.3.2 Check Valves

Provide check valves that permit free flow of sewage forward and provide a positive check against backflow. Design check valves for a minimum working pressure of 150 psi or as indicated. The body shall be iron. The manufacturer's name, initials, or trademark and also the size of the valve, working pressure, and direction of flow shall be directly cast on the body.

Swing Check Valves shall comply with AWWA C508 and shall be ductile iron body with resilient steel reinforced molded rubber flapper and shall have flanged ends. Flanges shall be the 125 pound type complying with ASME B16.1.

2.3.3 Pinch Valves

Pinch valves shall be double acting, jam-proof type with unobstructed streamlined flows and built-in operator. The body shall be iron with a non-rising handwheel. The sleeve shall be of pure gum rubber, neoprene, Buna N or hypalon as required for service. The valve shall have flanged ends. Flanges shall be of the 125 pound type complying with ASME B16.1.

2.3.4 Air Release Valves

Air release valves shall be designed to permit release of air from an empty pipe during filling and shall be capable of discharging accumulated air in the line while the line is in operation and under pressure. Valves shall be attached by means of threaded pipe connections. Valves shall be vented to the atmosphere.

a. Automatic Air Release Valve: Automatic air release valves shall be of the compound lever type capable of withstanding operating pressures of 150 psi. The valves shall have a 1/2 inch outlet. The body and cover of the valve shall be of iron with a stainless steel float. All internal parts shall be stainless steel or bronze. The valve shall be specifically adapted for use with sewage. Each valve shall be complete with hose and blow-off valves to permit backflushing without dismantling the valve.

2.4 VALVE VAULTS AND VENT MANHOLES

Valve vaults shall be precast concrete units manufactured in accordance with Section 03 40 00.00 10 PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION and conforming to ASTM C 478.

2.5 CASING PIPE

Casing pipe for bored underground crossings shall be carbon steel ASTM A53 Grade A, Schedule 20, coated inside and out with bitumastic coating per

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Shop Applied Coatings. Provide center positioned 304 stainless steel pipe spacers as indicated.

2.6 POLYETHYLENE ENCASEMENTSub Title

All buried ductile-iron pipe shall be encased in a seamless polyethylene tube, in accordance with AWWA C-105. The ends of adjacent sections of tubing shall be overlapped a minimum of 1 foot and the joint taped. All tears in tubing shall be repaired. Small pinholes less than 1/4 inch diameter need to be repaired.

2.7 MISCELLANEOUS MATERIALS

Miscellaneous materials shall comply with the following requirements:

2.7.1 Pipe Coatings and Linings

- a. Duct Iron interior: AWWA C104/A21.4 C104.

2.7.2 Joint Lubricants

Joint lubricants shall be as recommended by the pipe manufacturer.

2.7.3 Bolts, Nuts and Glands

AWWA C111/A21.11.

2.7.4 Joint Compound

A stiff mixture of graphite and oil or inert filler and oil.

2.7.5 Joint Tape

ASTM D 3308.

2.7.6 Bond Wire

Bond wire type RHW or USE, Size 1/0 AWG, neoprene jacketed copper conductor shaped to stand clear of the joint.

PART 3 EXECUTION

3.1 INSTALLATION

Pipe, pipe fittings, and appurtenances shall be installed at the locations indicated. Excavation, trenching, and backfilling shall be as specified in Section 31 23 02.98 EXCAVATION, BACKFILLING, AND COMPACTING FOR UTILITIES..

3.1.1 Adjacent Facilities

Installation of force mains near adjacent facilities shall be as specified in Section 31 23 02.98 EXCAVATION, BACKFILLING, AND COMPACTING FOR UTILITIES.

3.1.2 Cutting

Pipe shall be cut in a neat manner with mechanical cutters. Wheel cutters shall be used where practicable. Sharp and rough edges shall be ground smooth and loose material removed from the pipe before laying.

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3.1.3 Laying

Except where otherwise authorized, pipe shall be laid with bells facing the direction of laying. Unless otherwise approved by the COTR, pipe laying shall start at the discharge end and proceed toward the pump station with bells facing the pump station. Before lowering and while suspended, the pipe shall be inspected for defects. Defective material shall be rejected. Pipe shall be laid in compliance with the following:

- a. Ductile Iron: AWWA C600.

3.1.4 Jointing

3.1.4.1 Joints for Ductile Iron Pipe

Installation of mechanical and push-on type joints shall comply with AWWA C600 and the manufacturer's instructions. Installation of flanged joints shall comply with manufacturer's instructions.

3.1.5 Installation of Valves

Prior to installation, valves shall be cleaned of all foreign matter and inspected for damage. Valves shall be fully opened and closed to ensure that all parts are properly operating. Valves shall be installed with the stem in the vertical position.

3.1.6 Installation of Valve Vaults

Valve vaults shall be installed for check valve and bypass valve in force main.

3.1.7 Thrust Restraint

Thrust Restraint shall be as specified in Section 33 11 00 WATER DISTRIBUTION. Plugs, caps, tees and bends deflecting 11-1/4 degrees or more, either vertically or horizontally, shall be provided with thrust restraint. Valves shall be securely anchored or shall be provided with thrust restraints to prevent movement. Thrust restraints shall be thrust blocks.

3.1.7.1 Thrust Blocks

Thrust blocking shall be concrete of a mix not leaner than: 1 cement, 2-1/2 sand, 5 gravel; and having a compressive strength of not less than 2000 psi after 28 days. Blocking shall be placed between solid ground and the fitting to be anchored. Unless otherwise indicated or directed, the base and thrust bearing sides of thrust blocks shall be poured directly against undisturbed earth. The sides of thrust blocks not subject to thrust may be poured against forms. The area of bearing shall be as shown or as directed. Blocking shall be placed so that the fitting joints will be accessible for repair. Steel rods and clamps, protected by galvanizing or by coating with bituminous paint, shall be used to anchor vertical down bends into gravity thrust blocks. Bearing area shall be as indicated.

3.1.7.2 Restrained Joints

For ductile iron pipe, restrained joints shall be designed by the Contractor or the pipe manufacturer in accordance with DIPRA TRD Thrust

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blocks are required in addition to restrained joints..

3.2 HYDROSTATIC TESTS

The pipeline shall be subjected to both a pressure test and a leakage test. The method proposed for disposal of waste water from hydrostatic tests shall be approved by the Contracting Officer. Testing is the responsibility of the Contractor. Perform testing using an approved independent testing laboratory or the Contractor, subject to approval. The Contracting Officer shall be notified at least 7 days in advance of equipment tests. The final test report shall be delivered to the Contracting Officer within 30 days of the test.

3.2.1 Pressure Test

After the pipe has been installed, joints completed, thrust blocks have been in place for at least five days, and the trench has been partially backfilled, leaving the joints exposed for examination, the pipe shall be filled with water to expel all air. The pipeline shall be subjected to a test pressure of 100 psi or 150 percent of the working pressure, whichever is greater, for a period of at least one hour. Each valve shall be opened and closed several times during the test. The exposed pipe, joints, fitting, and valves shall be examined for leaks. Visible leaks shall be stopped or the defective pipe, fitting, joints, or valve shall be replaced.

3.2.2 Leakage Test

The leakage test may be conducted subsequent to or concurrently with the pressure test. The amount of water permitted as leakage for the line shall be placed in a sealed container attached to the supply side of the test pump. No other source of supply will be permitted to be applied to the pump or line under test. The water shall be pumped into the line by the test pump as required to maintain the specified test pressure as described for pressure test for a 2 hour period. Exhaustion of the supply or the inability to maintain the required pressure will be considered test failure. PE pipe can experience diametric expansion and pressure elongation during initial testing. The manufacturer shall be consulted prior to testing for special testing considerations. Allowable leakage shall be determined by the following I-P formula:

$L = NDP/K$ Where:

L = Allowable leakage in gallons per hour.

N = Number of joints in length of pipeline tested.

D = Nominal diameter of the pipe in inches.

P = Square root of the test pressure in psig.

K = 7400 for pipe materials.

At the conclusion of the test, the amount of water remaining in the container shall be measured and the results recorded in the test report.

3.2.3 Retesting

If any deficiencies are revealed during any test, such deficiencies shall be corrected and the tests shall be reconducted until the results of the

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tests are within specified allowances, without additional cost to the Government.

-- End of Section --

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SECTION 33 40 00

STORM DRAINAGE UTILITIES

01/08

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO HB-17 (2002; Errata 2003; Errata 2005) Standard Specifications for Highway Bridges

AASHTO M 167M/M 167 (2005) Corrugated Steel Structural Plate, Zinc-Coated, for Field-Bolted Pipe, Pipe-Arches and Arches

AASHTO M 190 (2004) Bituminous Coated Corrugated Metal Culvert Pipe and Pipe Arches

AASHTO M 198 (2005) Standard Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections Using Preformed Flexible Joint Sealants

AASHTO M 219 (1992; R 2004) Corrugated Aluminum Alloy Structural Plate for Field-Bolted Pipe, Pipe-Arches, and Arches

AASHTO M 243 (1996; R 2004) Field-Applied Coating of Corrugated Metal Structural Plate for Pipe, Pipe-Arches, and Arches

AASHTO M 294 (2007) Standard Specification for Corrugated Polyethylene Pipe, 300- to 1200-mm Diameter

AMERICAN RAILWAY ENGINEERING AND MAINTENANCE-OF-WAY ASSOCIATION (AREMA)

AREMA Eng Man (2007) Manual for Railway Engineering

ASTM INTERNATIONAL (ASTM)

ASTM A 123/A 123M (2002) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

ASTM A 48/A 48M (2003) Standard Specification for Gray Iron Castings

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ASTM A 536	(1984; R 2004) Standard Specification for Ductile Iron Castings
ASTM A 716	(2003) Standard Specification for Ductile Iron Culvert Pipe
ASTM A 74	(2006) Standard Specification for Cast Iron Soil Pipe and Fittings
ASTM A 742/A 742M	(2003) Standard Specification for Steel Sheet, Metallic Coated and Polymer Precoated for Corrugated Steel Pipe
ASTM A 760/A 760M	(2006) Standard Specification for Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains
ASTM A 762/A 762M	(2000) Standard Specification for Corrugated Steel Pipe, Polymer Precoated for Sewers and Drains
ASTM A 798/A 798M	(2001) Standard Practice for Installing Factory-Made Corrugated Steel Pipe for Sewers and Other Applications
ASTM A 807/A 807M	(2002e1) Standard Practice for Installing Corrugated Steel Structural Plate Pipe for Sewers and Other Applications
ASTM A 849	(2000; R 2005) Standard Specification for Post-Applied Coatings, Pavings, and Linings for Corrugated Steel Sewer and Drainage Pipe
ASTM A 929/A 929M	(2001; R 2007) Standard Specification for Steel Sheet, Metallic-Coated by the Hot-Dip Process for Corrugated Steel Pipe
ASTM B 26/B 26M	(2005) Standard Specification for Aluminum-Alloy Sand Castings
ASTM B 745/B 745M	(1997; R 2005) Standard Specification for Corrugated Aluminum Pipe for Sewers and Drains
ASTM C 1103	(2003) Standard Practice for Joint Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines
ASTM C 12	(2007) Standard Practice for Installing Vitrified Clay Pipe Lines
ASTM C 139	(2005) Standard Specification for Concrete Masonry Units for Construction of Catch Basins and Manholes
ASTM C 1433	(2007) Standard Specification for Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers

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ASTM C 231	(2004) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 270	(2007) Standard Specification for Mortar for Unit Masonry
ASTM C 425	(2004) Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings
ASTM C 443	(2005a) Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
ASTM C 478	(2007) Standard Specification for Precast Reinforced Concrete Manhole Sections
ASTM C 564	(2003a) Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings
ASTM C 700	(2007e1) Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated
ASTM C 828	(2006) Low-Pressure Air Test of Vitrified Clay Pipe Lines
ASTM C 877	(2002; E 2005) External Sealing Bands for Concrete Pipe, Manholes, and Precast Box Sections
ASTM C 923	(2007) Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals
ASTM C 924	(2002) Testing Concrete Pipe Sewer Lines by Low-Pressure Air Test Method
ASTM D 1056	(2007) Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber
ASTM D 1171	(1999) Rubber Deterioration - Surface Ozone Cracking Outdoors or Chamber (Triangular Specimens)
ASTM D 1557	(2002e1) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft ³) (2700 kN-m/m ³)
ASTM D 1751	(2004) Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient

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Bituminous Types)

ASTM D 1752	(2004a) Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion
ASTM D 1784	(2006a) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D 2167	(1994; R 2001) Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM D 2321	(2005) Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
ASTM D 2729	(2003) Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D 3034	(2006) Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D 3212	(1996a; R 2003e1) Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM D 3350	(2006) Polyethylene Plastics Pipe and Fittings Materials
ASTM D 6938	(2007a) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
ASTM F 1417	(1992; R 2005) Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low Pressure Air
ASTM F 477	(2007) Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F 679	(2006a) Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings
ASTM F 714	(2006a) Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter
ASTM F 794	(2003) Standard Specification for Poly(Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter
ASTM F 894	(2007) Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe

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ASTM F 949

(2006a) Poly(Vinyl Chloride) (PVC)
Corrugated Sewer Pipe with a Smooth
Interior and Fittings

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01 33 00
SUBMITTAL PROCEDURES:

SD-03 Product Data

Placing Pipe

Printed copies of the manufacturer's recommendations for
installation procedures of the material being placed, prior to
installation.

SD-07 Certificates

Resin Certification
Pipeline Testing
Hydrostatic Test on Watertight Joints
Determination of Density
Frame and Cover for Gratings

Certified copies of test reports demonstrating conformance to
applicable pipe specifications, before pipe is installed.
Certification on the ability of frame and cover or gratings to
carry the imposed live load.

1.3 DELIVERY, STORAGE, AND HANDLING

1.3.1 Delivery and Storage

Materials delivered to site shall be inspected for damage, unloaded, and
stored with a minimum of handling. Materials shall not be stored directly
on the ground. The inside of pipes and fittings shall be kept free of dirt
and debris. Before, during, and after installation, plastic pipe and
fittings shall be protected from any environment that would result in
damage or deterioration to the material. The Contractor shall have a copy
of the manufacturer's instructions available at the construction site at
all times and shall follow these instructions unless directed otherwise by
the Contracting Officer. Solvents, solvent compounds, lubricants,
elastomeric gaskets, and any similar materials required to install plastic
pipe shall be stored in accordance with the manufacturer's recommendations
and shall be discarded if the storage period exceeds the recommended shelf
life. Solvents in use shall be discarded when the recommended pot life is
exceeded.

1.3.2 Handling

Materials shall be handled in a manner that ensures delivery to the trench
in sound, undamaged condition. Pipe shall be carried to the trench, not
dragged.

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PART 2 PRODUCTS

2.1 PIPE FOR CULVERTS AND STORM DRAINS

Pipe for culverts and storm drains shall be of the sizes indicated and shall conform to the requirements specified.

2.1.1 Corrugated Steel Pipe

ASTM A 760/A 760M, zinc or aluminum (Type 2) coated pipe of either:

- a. Type I pipe with helical 2-2/3 by 1/2 inch corrugations.
- b. Type IIR pipe with helical 3/4 by 3/4 by 7-1/2 inch corrugations.

2.1.1.1 Fully Bituminous Coated

AASHTO M 190 Type A and ASTM A 760/A 760M zinc or aluminum (Type 2) coated pipe of either:

- a. Type I pipe with annular helical 2-2/3 by 1/2 inch corrugations.
- b. Type IIR pipe with helical 3/4 by 3/4 by 7-1/2 inch corrugations.

2.1.1.2 Polymer Precoated

ASTM A 762/A 762M corrugated steel pipe fabricated from ASTM A 742/A 742M Grade 10/10 polymer precoated sheet of either:

- a. Type I pipe with helical 2-2/3 by 1/2 inch corrugations.
- b. Type IIR pipe with helical 3/4 by 3/4 by 7-1/2 inch corrugations.

2.1.2 Corrugated Aluminum Alloy Pipe

ASTM B 745/B 745M corrugated aluminum alloy pipe of either:

- a. Type I pipe with helical corrugations.
- b. Type IIR pipe with helical corrugations.

2.1.2.1 Aluminum Fully Bituminous Coated

Bituminous coating shall conform to ASTM A 849 Type B. Piping shall conform to AASHTO M 190 Type A and ASTM B 745/B 745M corrugated aluminum alloy pipe of either:

- a. Type I pipe with helical corrugations.
- b. Type IIR pipe with helical corrugations.

2.1.3 Structural Plate, Steel Pipe, Pipe Arches and Arches

Assembled with galvanized steel nuts and bolts, from galvanized corrugated steel plates conforming to AASHTO M 167M/M 167. Pipe coating, when required, shall conform to the requirements of AASHTO M 190 Type A. Thickness of plates shall be as indicated.

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2.1.4 Structural Plate, Aluminum Pipe, Pipe Arches and Arches

Assembled with either aluminum alloy, aluminum coated steel, stainless steel or zinc coated steel nuts and bolts. Nuts and bolts, and aluminum alloy plates shall conform to [AASHTO M 219](#). Pipe coating, when required, shall conform to the requirements of [AASHTO M 190](#), Type A. Thickness of plates shall be as indicated.

2.1.5 Ductile Iron Culvert Pipe

[ASTM A 716](#).

2.1.6 Cast-Iron Soil Piping

Cast-Iron Soil Pipe shall conform to [ASTM A 74](#), service-weight; gaskets shall be compression-type rubber conforming to [ASTM C 564](#).

2.1.7 Perforated Piping

2.1.7.1 Clay Pipe

[ASTM C 700](#), standard strength.

2.1.7.2 Corrugated Steel Pipe

[ASTM A 760/A 760M](#), Type III, zinc-coated.

2.1.7.3 Corrugated Aluminum Pipe

[ASTM B 745/B 745M](#), Type III.

2.1.7.4 PVC Pipe

[ASTM D 2729](#).

2.1.8 PVC Pipe

The pipe manufacturer's [resin certification](#), indicating the cell classification of PVC used to manufacture the pipe, shall be submitted prior to installation of the pipe.

2.1.8.1 Type PSM PVC Pipe

[ASTM D 3034](#), Type PSM, maximum SDR 35, produced from PVC certified by the compounder as meeting the requirements of [ASTM D 1784](#), minimum cell class 12454-B.

2.1.8.2 Profile PVC Pipe

[ASTM F 794](#), Series 46, produced from PVC certified by the compounder as meeting the requirements of [ASTM D 1784](#), minimum cell class 12454-B.

2.1.8.3 Smooth Wall PVC Pipe

[ASTM F 679](#) produced from PVC certified by the compounder as meeting the requirements of [ASTM D 1784](#), minimum cell class 12454-B.

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2.1.1.8.4 Corrugated PVC Pipe

ASTM F 949 produced from PVC certified by the compounder as meeting the requirements of ASTM D 1784, minimum cell class 12454-B.

2.1.1.9 PE Pipe

The pipe manufacturer's resin certification indicating the cell classification of PE used to manufacture the pipe shall be submitted prior to installation of the pipe. The minimum cell classification for polyethylene plastic shall apply to each of the seven primary properties of the cell classification limits in accordance with ASTM D 3350.

2.1.1.9.1 Smooth Wall PE Pipe

ASTM F 714, maximum DR of 21 for pipes 3 to 24 inches in diameter and maximum DR of 26 for pipes 26 to 48 inches in diameter. Pipe shall be produced from PE certified by the resin producer as meeting the requirements of ASTM D 3350, minimum cell class 335434C.

2.1.1.9.2 Corrugated PE Pipe

AASHTO M 294, Type S or D, for pipes 12 to 48 inches and AASHTO M 294, Type S or D, for pipes 54 to 60 inches produced from PE certified by the resin producer as meeting the requirements of ASTM D 3350, minimum cell class in accordance with AASHTO M 294. Pipe walls shall have the following properties:

Nominal Size (in.)	Minimum Wall Area (square in/ft)	Minimum Moment of Inertia of Wall Section (in to the 4th/in)
12	1.50	0.024
15	1.91	0.053
18	2.34	0.062
24	3.14	0.116
30	3.92	0.163
36	4.50	0.222
42	4.69	0.543
48	5.15	0.543
54	5.67	0.800
60	6.45	0.800

2.1.1.9.3 Profile Wall PE Pipe

ASTM F 894, RSC 160, produced from PE certified by the resin producer as meeting the requirements of ASTM D 3350, minimum cell class 334433C. Pipe walls shall have the following properties:

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Nominal Size (in.)	Minimum Wall Area (square in/ft)	Minimum Moment Of Inertia of Wall Section (in to the 4th/in)	
		Cell Class 334433C	Cell Class 335434C
18	2.96	0.052	0.038
21	4.15	0.070	0.051
24	4.66	0.081	0.059
27	5.91	0.125	0.091
30	5.91	0.125	0.091
33	6.99	0.161	0.132
36	8.08	0.202	0.165
42	7.81	0.277	0.227
48	8.82	0.338	0.277

2.2 DRAINAGE STRUCTURES

2.2.1 Flared End Sections

Sections shall be of a standard design fabricated from zinc coated steel sheets meeting requirements of [ASTM A 929/A 929M](#).

2.2.2 Precast Reinforced Concrete Box

Precast reinforced concrete box shall be manufactured in accordance with Section [03 40 00.00 10](#) PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION. Boxes subjected to highway loadings shall conform to [ASTM C 1433](#).

2.3 MISCELLANEOUS MATERIALS

2.3.1 Concrete

Unless otherwise specified, concrete and reinforced concrete shall conform to the requirements for 3000 [psi](#) concrete under Section [03 30 00](#) CAST-IN-PLACE CONCRETE. The concrete mixture shall have air content by volume of concrete, based on measurements made immediately after discharge from the mixer, of 5 to 7 percent when maximum size of coarse aggregate exceeds [1-1/2 inches](#). Air content shall be determined in accordance with [ASTM C 231](#). The concrete covering over steel reinforcing shall not be less than [1 inch](#) thick for covers and not less than [1-1/2 inches](#) thick for walls and flooring. Concrete covering deposited directly against the ground shall have a thickness of at least [3 inches](#) between steel and ground. Expansion-joint filler material shall conform to [ASTM D 1751](#), or [ASTM D 1752](#), or shall be resin-impregnated fiberboard conforming to the physical requirements of [ASTM D 1752](#).

2.3.2 Mortar

Mortar for pipe joints, connections to other drainage structures, and brick or block construction shall conform to [ASTM C 270](#), Type M, except that the maximum placement time shall be 1 hour. The quantity of water in the

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mixture shall be sufficient to produce a stiff workable mortar. Water shall be clean and free of harmful acids, alkalies, and organic impurities. The mortar shall be used within 30 minutes after the ingredients are mixed with water. The inside of the joint shall be wiped clean and finished smooth. The mortar head on the outside shall be protected from air and sun with a proper covering until satisfactorily cured.

2.3.3 Precast Concrete Segmental Blocks

Precast concrete segmental block shall conform to [ASTM C 139](#), not more than [8 inches](#) thick, not less than [8 inches](#) long, and of such shape that joints can be sealed effectively and bonded with cement mortar.

2.3.4 Precast Reinforced Concrete Manholes

Precast reinforced concrete manholes shall be manufactured in accordance with Section [03 40 00.00 10](#) PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION and conform to [ASTM C 478](#). Joints between precast concrete risers and tops shall be made with flexible watertight, rubber-type gaskets meeting the requirements of paragraph JOINTS.

2.3.5 Prefabricated Corrugated Metal Manholes

Manholes shall be of the type and design recommended by the manufacturer. Manholes shall be complete with frames and cover, or frames and gratings.

2.3.6 Frame and Cover for Gratings

Frame and cover for gratings shall be cast gray iron, [ASTM A 48/A 48M](#), Class 35B; cast ductile iron, [ASTM A 536](#), Grade 65-45-12; or cast aluminum, [ASTM B 26/B 26M](#), Alloy 356.OT6. Weight, shape, size, and waterway openings for grates and curb inlets shall be as indicated on the plans.

2.3.7 Joints

2.3.7.1 Flexible Watertight Joints

a. Materials: Flexible watertight joints shall be made with plastic or rubber-type gaskets for concrete pipe and with factory-fabricated resilient materials for clay pipe. The design of joints and the physical requirements for plastic gaskets shall conform to [AASHTO M 198](#), and rubber-type gaskets shall conform to [ASTM C 443](#). Factory-fabricated resilient joint materials shall conform to [ASTM C 425](#). Gaskets shall have not more than one factory-fabricated splice, except that two factory-fabricated splices of the rubber-type gasket are permitted if the nominal diameter of the pipe being gasketed exceeds [54 inches](#).

b. Test Requirements: Watertight joints shall be tested and shall meet test requirements of paragraph HYDROSTATIC TEST ON WATERTIGHT JOINTS. Rubber gaskets shall comply with the oil resistant gasket requirements of [ASTM C 443](#). Certified copies of test results shall be delivered to the Contracting Officer before gaskets or jointing materials are installed. Alternate types of watertight joint may be furnished, if specifically approved.

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2.3.7.2 External Sealing Bands

Requirements for external sealing bands shall conform to [ASTM C 877](#).

2.3.7.3 Flexible Watertight, Gasketed Joints

a. Gaskets: When infiltration or exfiltration is a concern for pipe lines, the couplings may be required to have gaskets. The closed-cell expanded rubber gaskets shall be a continuous band approximately [7 inches](#) wide and approximately [3/8 inch](#) thick, meeting the requirements of [ASTM D 1056](#), Type 2 A1, and shall have a quality retention rating of not less than 70 percent when tested for weather resistance by ozone chamber exposure, Method B of [ASTM D 1171](#). Rubber O-ring gaskets shall be [13/16 inch](#) in diameter for pipe diameters of [36 inches](#) or smaller and [7/8 inch](#) in diameter for larger pipe having [1/2 inch](#) deep end corrugation. Rubber O-ring gaskets shall be [1-3/8 inches](#) in diameter for pipe having [1 inch](#) deep end corrugations. O-rings shall meet the requirements of [AASHTO M 198](#) or [ASTM C 443](#). Flexible plastic gaskets shall conform to requirements of [AASHTO M 198](#), Type B.

b. Connecting Bands: Connecting bands shall be of the type, size and sheet thickness of band, and the size of angles, bolts, rods and lugs as indicated or where not indicated as specified in the applicable standards or specifications for the pipe. Exterior rivet heads in the longitudinal seam under the connecting band shall be countersunk or the rivets shall be omitted and the seam welded. Watertight joints shall be tested and shall meet the test requirements of paragraph HYDROSTATIC TEST ON WATERTIGHT JOINTS.

2.3.7.4 PVC Plastic Pipes

Joints shall be solvent cement or elastomeric gasket type in accordance with the specification for the pipe and as recommended by the pipe manufacturer.

2.3.7.5 Smooth Wall PE Plastic Pipe

Pipe shall be joined using butt fusion method as recommended by the pipe manufacturer.

2.3.7.6 Corrugated PE Plastic Pipe

Water tight joints shall be made using a PVC or PE coupling and rubber gaskets as recommended by the pipe manufacturer. Rubber gaskets shall conform to [ASTM F 477](#). Soil tight joints shall conform to the requirements in [AASHTO HB-17](#), Division II, Section 26.4.2.4. (e) for soil tightness and shall be as recommended by the pipe manufacturer.

2.3.7.7 Profile Wall PE Plastic Pipe

Joints shall be gasketed or thermal weld type with integral bell in accordance with [ASTM F 894](#).

2.3.7.8 Ductile Iron Pipe

Couplings and fittings shall be as recommended by the pipe manufacturer.

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2.3.8 Flap Gates

Flap Gates shall be medium with circular opening and double-hinged. Top pivot points shall be adjustable. The seat shall be one-piece cast iron with a raised section around the perimeter of the waterway opening to provide the seating face. The seating face of the seat shall be cast iron. The cover shall be one-piece cast iron with necessary reinforcing rib, lifting eye for manual operation, and bosses to provide a pivot point connection with the links. The seating face of the cover shall be cast iron. Links or hinge arms shall be cast or ductile iron. Holes of pivot points shall be bronze bushed. All fasteners shall be either galvanized steel, bronze or stainless steel.

2.4 STEEL LADDER

Steel ladder shall be provided where the depth of the storm drainage structure exceeds 12 feet. These ladders shall be not less than 16 inches in width, with 3/4 inch diameter rungs spaced 12 inches apart. The two stringers shall be a minimum 3/8 inch thick and 2-1/2 inches wide. Ladders and inserts shall be galvanized after fabrication in conformance with ASTM A 123/A 123M.

2.5 DOWNSPOUT BOOTS

Boots used to connect exterior downspouts to the storm-drainage system shall be of gray cast iron conforming to ASTM A 48/A 48M, Class 30B or 35B. Shape and size shall be as indicated.

2.6 RESILIENT CONNECTORS

Flexible, watertight connectors used for connecting pipe to manholes and inlets shall conform to ASTM C 923.

2.7 HYDROSTATIC TEST ON WATERTIGHT JOINTS

2.7.1 Concrete, Clay, PVC and PE Pipe

A hydrostatic test shall be made on the watertight joint types as proposed. Only one sample joint of each type needs testing; however, if the sample joint fails because of faulty design or workmanship, an additional sample joint may be tested. During the test period, gaskets or other jointing material shall be protected from extreme temperatures which might adversely affect the performance of such materials. Performance requirements for joints in reinforced and nonreinforced concrete pipe shall conform to AASHTO M 198 or ASTM C 443. Test requirements for joints in clay pipe shall conform to ASTM C 425. Test requirements for joints in PVC and PE plastic pipe shall conform to ASTM D 3212.

2.7.2 Corrugated Steel and Aluminum Pipe

A hydrostatic test shall be made on the watertight joint system or coupling band type proposed. The moment strength required of the joint is expressed as 15 percent of the calculated moment capacity of the pipe on a transverse section remote from the joint by the AASHTO HB-17 (Division II, Section 26). The pipe shall be supported for the hydrostatic test with the joint located at the point which develops 15 percent of the moment capacity of the pipe based on the allowable span in feet for the pipe flowing full or 40,000 foot-pounds, whichever is less. Performance requirements shall be met at an internal hydrostatic pressure of 10 psi, for a 10 minute period

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for both annular corrugated metal pipe and helical corrugated metal pipe with factory reformed ends.

2.8 EROSION CONTROL RIPRAP

Provide nonerodible rock not exceeding 15 inches in its greatest dimension and choked with sufficient small rocks to provide a dense mass with a minimum thickness of 8 inches.

PART 3 EXECUTION

3.1 EXCAVATION FOR PIPE CULVERTS, STORM DRAINS, AND DRAINAGE STRUCTURES

Excavation of trenches, and for appurtenances and backfilling for culverts and storm drains, shall be in accordance with the requirements specified below.

3.1.1 Trenching

The width of trenches at any point below the top of the pipe shall be not greater than the outside diameter of the pipe plus 18 inches to permit satisfactory jointing and thorough tamping of the bedding material under and around the pipe. Sheet piling and bracing, where required, shall be placed within the trench width as specified. Contractor shall not overexcavate. Where trench widths are exceeded, redesign with a resultant increase in cost of stronger pipe or special installation procedures will be necessary. Cost of this redesign and increased cost of pipe or installation shall be borne by the Contractor without additional cost to the Government.

3.1.2 Removal of Rock

Rock in either ledge or boulder formation shall be replaced with suitable materials to provide a compacted earth cushion having a thickness between unremoved rock and the pipe of at least 8 inches or 1/2 inch for each foot of fill over the top of the pipe, whichever is greater, but not more than three-fourths the nominal diameter of the pipe. Where bell-and-spigot pipe is used, the cushion shall be maintained under the bell as well as under the straight portion of the pipe.

3.1.3 Removal of Unstable Material

Where wet or otherwise unstable soil incapable of properly supporting the pipe, as determined by the Contracting Officer, is unexpectedly encountered in the bottom of a trench, such material shall be removed to the depth required and replaced to the proper grade with select granular material, compacted as provided in paragraph BACKFILLING. When removal of unstable material is due to the fault or neglect of the Contractor while performing shoring and sheet piling, water removal, or other specified requirements, such removal and replacement shall be performed at no additional cost to the Government.

3.2 BEDDING

The bedding surface for the pipe shall provide a firm foundation of uniform density throughout the entire length of the pipe.

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3.2.1 Concrete Pipe Requirements

When no bedding class is specified or detailed on the drawings, concrete pipe shall be bedded in a soil foundation accurately shaped and rounded to conform to the lowest one-fourth of the outside portion of circular pipe or to the lower curved portion of pipe arch for the entire length of the pipe or pipe arch. When necessary, the bedding shall be tamped. Bell holes and depressions for joints shall be not more than the length, depth, and width required for properly making the particular type of joint.

3.2.2 Clay Pipe Requirements

Bedding for clay pipe shall be as specified by [ASTM C 12](#).

3.2.3 Corrugated Metal Pipe

Bedding for corrugated metal pipe and pipe arch shall be in accordance with [ASTM A 798/A 798M](#). It is not required to shape the bedding to the pipe geometry. However, for pipe arches, the Contractor shall either shape the bedding to the relatively flat bottom arc or fine grade the foundation to a shallow v-shape. Bedding for corrugated structural plate pipe shall meet requirements of [ASTM A 807/A 807M](#).

3.2.4 Ductile Iron and Cast-Iron Pipe

Bedding for ductile iron and cast-iron pipe shall be as shown on the drawings.

3.2.5 Plastic Pipe

Bedding for PVC and PE pipe shall meet the requirements of [ASTM D 2321](#). Bedding, haunching, and initial backfill shall be either Class IB or II material.

3.3 PLACING PIPE

Each pipe shall be thoroughly examined before being laid; defective or damaged pipe shall not be used. Plastic pipe shall be protected from exposure to direct sunlight prior to laying, if necessary to maintain adequate pipe stiffness and meet installation deflection requirements. Pipelines shall be laid to the grades and alignment indicated. Proper facilities shall be provided for lowering sections of pipe into trenches. Lifting lugs in vertically elongated metal pipe shall be placed in the same vertical plane as the major axis of the pipe. Pipe shall not be laid in water, and pipe shall not be laid when trench conditions or weather are unsuitable for such work. Diversion of drainage or dewatering of trenches during construction shall be provided as necessary. Deflection of installed flexible pipe shall not exceed the following limits:

TYPE OF PIPE	MAXIMUM ALLOWABLE DEFLECTION (%)
Corrugated Steel and Aluminum Alloy	5
Concrete-Lined Corrugated Steel	3
Ductile Iron Culvert	3

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	TYPE OF PIPE	MAXIMUM ALLOWABLE DEFLECTION (%)
	Plastic	7.5

Not less than 30 days after the completion of backfilling, the Government may perform a deflection test on the entire length of installed flexible pipe using a mandrel or other suitable device. Installed flexible pipe showing deflections greater than those indicated above shall be retested by a run from the opposite direction. If the retest also fails, the suspect pipe shall be replaced.

3.3.1 Concrete, Clay, PVC, Ribbed PVC, Ductile Iron and Cast-Iron Pipe

Laying shall proceed upgrade with spigot ends of bell-and-spigot pipe and tongue ends of tongue-and-groove pipe pointing in the direction of the flow.

3.3.2 Elliptical and Elliptical Reinforced Concrete Pipe

The manufacturer's reference lines, designating the top of the pipe, shall be within 5 degrees of a vertical plane through the longitudinal axis of the pipe, during placement. Damage to or misalignment of the pipe shall be prevented in all backfilling operations.

3.3.3 Corrugated PE Pipe

Laying shall be with the separate sections joined firmly on a bed shaped to line and grade and shall follow manufacturer's recommendations.

3.3.4 Corrugated Metal Pipe and Pipe Arch

Laying shall be with the separate sections joined firmly together, with the outside laps of circumferential joints pointing upstream, and with longitudinal laps on the sides. Part paved pipe shall be installed so that the centerline of bituminous pavement in the pipe, indicated by suitable markings on the top at each end of the pipe sections, coincides with the specified alignment of pipe. Fully paved steel pipe or pipe arch shall have a painted or otherwise applied label inside the pipe or pipe arch indicating sheet thickness of pipe or pipe arch. Any unprotected metal in the joints shall be coated with bituminous material as specified in [AASHTO M 190](#) or [AASHTO M 243](#). Interior coating shall be protected against damage from insertion or removal of struts or tie wires. Lifting lugs shall be used to facilitate moving pipe without damage to exterior or interior coatings. During transportation and installation, pipe or pipe arch and coupling bands shall be handled with care to preclude damage to the coating, paving or lining. Damaged coatings, pavings and linings shall be repaired in accordance with the manufacturer's recommendations prior to placing backfill. Pipe on which coating, paving or lining has been damaged to such an extent that satisfactory field repairs cannot be made shall be removed and replaced. Vertical elongation, where indicated, shall be accomplished by factory elongation. Suitable markings or properly placed lifting lugs shall be provided to ensure placement of factory elongated pipe in a vertical plane.

3.3.5 Structural-Plate Steel

Structural plate shall be installed in accordance with [ASTM A 807/A 807M](#). Structural plate shall be assembled in accordance with instructions

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furnished by the manufacturer. Instructions shall show the position of each plate and the order of assembly. Bolts shall be tightened progressively and uniformly, starting at one end of the structure after all plates are in place. The operation shall be repeated to ensure that all bolts are tightened to meet the torque requirements of 200 foot-pounds plus or minus 50 foot-pounds. Any power wrenches used shall be checked by the use of hand torque wrenches or long-handled socket or structural wrenches for amount of torque produced. Power wrenches shall be checked and adjusted frequently as needed, according to type or condition, to ensure proper adjustment to supply the required torque.

3.3.6 Structural-Plate Aluminum

Structural plate shall be assembled in accordance with instructions furnished by the manufacturer. Instructions shall show the position of each plate and the order of assembly. Bolts shall be tightened progressively and uniformly, starting at one end of the structure after all plates are in place. The operation shall be repeated to ensure that all bolts are torqued to a minimum of 100 foot-pounds on aluminum alloy bolts and a minimum of 150 foot-pounds on galvanized steel bolts. Any power wrenches used shall be checked by the use of hand torque wrenches or long-handled socket or structural wrenches for the amount of torque produced. Power wrenches shall be checked and adjusted as frequently as needed, according to type or condition, to ensure that they are in proper adjustment to supply the required torque.

3.3.7 Multiple Culverts

Where multiple lines of pipe are installed, adjacent sides of pipe shall be at least half the nominal pipe diameter or 3 feet apart, whichever is less.

3.3.8 Jacking Pipe Through Fills

Methods of operation and installation for jacking pipe through fills shall conform to requirements specified in Volume 1, Chapter 1, Part 4 of AREMA Eng Man.

3.4 JOINTING

3.4.1 Concrete and Clay Pipe

3.4.1.1 Cement-Mortar Bell-and-Spigot Joint

The first pipe shall be bedded to the established gradeline, with the bell end placed upstream. The interior surface of the bell shall be thoroughly cleaned with a wet brush and the lower portion of the bell filled with mortar as required to bring inner surfaces of abutting pipes flush and even. The spigot end of each subsequent pipe shall be cleaned with a wet brush and uniformly matched into a bell so that sections are closely fitted. After each section is laid, the remainder of the joint shall be filled with mortar, and a bead shall be formed around the outside of the joint with sufficient additional mortar. If mortar is not sufficiently stiff to prevent appreciable slump before setting, the outside of the joint shall be wrapped or bandaged with cheesecloth to hold mortar in place.

3.4.1.2 Cement-Mortar Oakum Joint for Bell-and-Spigot Pipe

A closely twisted gasket shall be made of jute or oakum of the diameter required to support the spigot end of the pipe at the proper grade and to

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make the joint concentric. Joint packing shall be in one piece of sufficient length to pass around the pipe and lap at top. This gasket shall be thoroughly saturated with neat cement grout. The bell of the pipe shall be thoroughly cleaned with a wet brush, and the gasket shall be laid in the bell for the lower third of the circumference and covered with mortar. The spigot of the pipe shall be thoroughly cleaned with a wet brush, inserted in the bell, and carefully driven home. A small amount of mortar shall be inserted in the annular space for the upper two-thirds of the circumference. The gasket shall be lapped at the top of the pipe and driven home in the annular space with a caulking tool. The remainder of the annular space shall be filled completely with mortar and beveled at an angle of approximately 45 degrees with the outside of the bell. If mortar is not sufficiently stiff to prevent appreciable slump before setting, the outside of the joint thus made shall be wrapped with cheesecloth. Placing of this type of joint shall be kept at least five joints behind laying operations.

3.4.1.3 Cement-Mortar Diaper Joint for Bell-and-Spigot Pipe

The pipe shall be centered so that the annular space is uniform. The annular space shall be caulked with jute or oakum. Before caulking, the inside of the bell and the outside of the spigot shall be cleaned.

- a. Diaper Bands: Diaper bands shall consist of heavy cloth fabric to hold grout in place at joints and shall be cut in lengths that extend one-eighth of the circumference of pipe above the spring line on one side of the pipe and up to the spring line on the other side of the pipe. Longitudinal edges of fabric bands shall be rolled and stitched around two pieces of wire. Width of fabric bands shall be such that after fabric has been securely stitched around both edges on wires, the wires will be uniformly spaced not less than 8 inches apart. Wires shall be cut into lengths to pass around pipe with sufficient extra length for the ends to be twisted at top of pipe to hold the band securely in place; bands shall be accurately centered around lower portion of joint.
- b. Grout: Grout shall be poured between band and pipe from the high side of band only, until grout rises to the top of band at the spring line of pipe, or as nearly so as possible, on the opposite side of pipe, to ensure a thorough sealing of joint around the portion of pipe covered by the band. Silt, slush, water, or polluted mortar grout forced up on the lower side shall be forced out by pouring, and removed.
- c. Remainder of Joint: The remaining unfilled upper portion of the joint shall be filled with mortar and a bead formed around the outside of this upper portion of the joint with a sufficient amount of additional mortar. The diaper shall be left in place. Placing of this type of joint shall be kept at least five joints behind actual laying of pipe. No backfilling around joints shall be done until joints have been fully inspected and approved.

3.4.1.4 Cement-Mortar Tongue-and-Groove Joint

The first pipe shall be bedded carefully to the established gradeline with the groove upstream. A shallow excavation shall be made underneath the pipe at the joint and filled with mortar to provide a bed for the pipe. The grooved end of the first pipe shall be thoroughly cleaned with a wet brush, and a layer of soft mortar applied to the lower half of the groove. The tongue of the second pipe shall be cleaned with a wet brush; while in

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horizontal position, a layer of soft mortar shall be applied to the upper half of the tongue. The tongue end of the second pipe shall be inserted in the grooved end of the first pipe until mortar is squeezed out on interior and exterior surfaces. Sufficient mortar shall be used to fill the joint completely and to form a bead on the outside.

3.4.1.5 Cement-Mortar Diaper Joint for Tongue-and-Groove Pipe

The joint shall be of the type described for cement-mortar tongue-and-groove joint in this paragraph, except that the shallow excavation directly beneath the joint shall not be filled with mortar until after a gauze or cheesecloth band dipped in cement mortar has been wrapped around the outside of the joint. The cement-mortar bead at the joint shall be at least 1/2 inch, thick and the width of the diaper band shall be at least 8 inches. The diaper shall be left in place. Placing of this type of joint shall be kept at least five joints behind the actual laying of the pipe. Backfilling around the joints shall not be done until the joints have been fully inspected and approved.

3.4.1.6 Plastic Sealing Compound Joints for Tongue-and-Grooved Pipe

Sealing compounds shall follow the recommendation of the particular manufacturer in regard to special installation requirements. Surfaces to receive lubricants, primers, or adhesives shall be dry and clean. Sealing compounds shall be affixed to the pipe not more than 3 hours prior to installation of the pipe, and shall be protected from the sun, blowing dust, and other deleterious agents at all times. Sealing compounds shall be inspected before installation of the pipe, and any loose or improperly affixed sealing compound shall be removed and replaced. The pipe shall be aligned with the previously installed pipe, and the joint pulled together. If, while making the joint with mastic-type sealant, a slight protrusion of the material is not visible along the entire inner and outer circumference of the joint when the joint is pulled up, the pipe shall be removed and the joint remade. After the joint is made, all inner protrusions shall be cut off flush with the inner surface of the pipe. If nonmastic-type sealant material is used, the "Squeeze-Out" requirement above will be waived.

3.4.1.7 Flexible Watertight Joints

Gaskets and jointing materials shall be as recommended by the particular manufacturer in regard to use of lubricants, cements, adhesives, and other special installation requirements. Surfaces to receive lubricants, cements, or adhesives shall be clean and dry. Gaskets and jointing materials shall be affixed to the pipe not more than 24 hours prior to the installation of the pipe, and shall be protected from the sun, blowing dust, and other deleterious agents at all times. Gaskets and jointing materials shall be inspected before installing the pipe; any loose or improperly affixed gaskets and jointing materials shall be removed and replaced. The pipe shall be aligned with the previously installed pipe, and the joint pushed home. If, while the joint is being made the gasket becomes visibly dislocated the pipe shall be removed and the joint remade.

3.4.1.8 External Sealing Band Joint for Noncircular Pipe

Surfaces to receive sealing bands shall be dry and clean. Bands shall be installed in accordance with manufacturer's recommendations.

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3.4.2 Corrugated Metal Pipe

3.4.2.1 Field Joints

Transverse field joints shall be designed so that the successive connection of pipe sections will form a continuous line free of appreciable irregularities in the flow line. In addition, the joints shall meet the general performance requirements described in [ASTM A 798/A 798M](#). Suitable transverse field joints which satisfy the requirements for one or more of the joint performance categories can be obtained with the following types of connecting bands furnished with suitable band-end fastening devices: corrugated bands, bands with projections, flat bands, and bands of special design that engage factory reformed ends of corrugated pipe. The space between the pipe and connecting bands shall be kept free from dirt and grit so that corrugations fit snugly. The connecting band, while being tightened, shall be tapped with a soft-head mallet of wood, rubber or plastic, to take up slack and ensure a tight joint. Field joints for each type of corrugated metal pipe shall maintain pipe alignment during construction and prevent infiltration of fill material during the life of the installations. The type, size, and sheet thickness of the band and the size of angles or lugs and bolts shall be as indicated or where not indicated, shall be as specified in the applicable standards or specifications for the pipe.

3.4.2.2 Flexible Watertight, Gasketed Joints

Installation shall be as recommended by the gasket manufacturer for use of lubricants and cements and other special installation requirements. The gasket shall be placed over one end of a section of pipe for half the width of the gasket. The other half shall be doubled over the end of the same pipe. When the adjoining section of pipe is in place, the doubled-over half of the gasket shall then be rolled over the adjoining section. Any unevenness in overlap shall be corrected so that the gasket covers the end of pipe sections equally. Connecting bands shall be centered over adjoining sections of pipe, and rods or bolts placed in position and nuts tightened. Band Tightening: The band shall be tightened evenly, even tension being kept on the rods or bolts, and the gasket; the gasket shall seat properly in the corrugations. Watertight joints shall remain uncovered for a period of time designated, and before being covered, tightness of the nuts shall be measured with a torque wrench. If the nut has tended to loosen its grip on the bolts or rods, the nut shall be retightened with a torque wrench and remain uncovered until a tight, permanent joint is assured.

3.5 DRAINAGE STRUCTURES

3.5.1 Manholes and Inlets

Construction shall be of reinforced concrete, plain concrete, brick, precast reinforced concrete, precast concrete segmental blocks, prefabricated corrugated metal, or bituminous coated corrugated metal; complete with frames and covers or gratings; and with fixed galvanized steel ladders where indicated. Pipe studs and junction chambers of prefabricated corrugated metal manholes shall be fully bituminous-coated and paved when the connecting branch lines are so treated. Pipe connections to concrete manholes and inlets shall be made with flexible, watertight connectors.

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3.5.2 Walls and Headwalls

Construction shall be as indicated.

3.6 STEEL LADDER INSTALLATION

Ladder shall be adequately anchored to the wall by means of steel inserts spaced not more than 6 feet vertically, and shall be installed to provide at least 6 inches of space between the wall and the rungs. The wall along the line of the ladder shall be vertical for its entire length.

3.7 BACKFILLING

3.7.1 Backfilling Pipe in Trenches

After the pipe has been properly bedded, selected material from excavation or borrow, at a moisture content that will facilitate compaction, shall be placed along both sides of pipe in layers not exceeding 6 inches in compacted depth. The backfill shall be brought up evenly on both sides of pipe for the full length of pipe. The fill shall be thoroughly compacted under the haunches of the pipe. Each layer shall be thoroughly compacted with mechanical tampers or rammers. This method of filling and compacting shall continue until the fill has reached an elevation of at least 12 inches above the top of the pipe. The remainder of the trench shall be backfilled and compacted by spreading and rolling or compacted by mechanical rammers or tampers in layers not exceeding 8 inches. Tests for density shall be made as necessary to ensure conformance to the compaction requirements specified below. Where it is necessary, in the opinion of the Contracting Officer, that sheeting or portions of bracing used be left in place, the contract will be adjusted accordingly. Untreated sheeting shall not be left in place beneath structures or pavements.

3.7.2 Backfilling Pipe in Fill Sections

For pipe placed in fill sections, backfill material and the placement and compaction procedures shall be as specified below. The fill material shall be uniformly spread in layers longitudinally on both sides of the pipe, not exceeding 6 inches in compacted depth, and shall be compacted by rolling parallel with pipe or by mechanical tamping or ramming. Prior to commencing normal filling operations, the crown width of the fill at a height of 12 inches above the top of the pipe shall extend a distance of not less than twice the outside pipe diameter on each side of the pipe or 12 feet, whichever is less. After the backfill has reached at least 12 inches above the top of the pipe, the remainder of the fill shall be placed and thoroughly compacted in layers not exceeding 8 inches.

3.7.3 Movement of Construction Machinery

When compacting by rolling or operating heavy equipment parallel with the pipe, displacement of or injury to the pipe shall be avoided. Movement of construction machinery over a culvert or storm drain at any stage of construction shall be at the Contractor's risk. Any damaged pipe shall be repaired or replaced.

3.7.4 Compaction

3.7.4.1 General Requirements

Cohesionless materials include gravels, gravel-sand mixtures, sands, and

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gravelly sands. Cohesive materials include clayey and silty gravels, gravel-silt mixtures, clayey and silty sands, sand-clay mixtures, clays, silts, and very fine sands. When results of compaction tests for moisture-density relations are recorded on graphs, cohesionless soils will show straight lines or reverse-shaped moisture-density curves, and cohesive soils will show normal moisture-density curves.

3.7.4.2 Minimum Density

Backfill over and around the pipe and backfill around and adjacent to drainage structures shall be compacted at the approved moisture content to the following applicable minimum density, which will be determined as specified below.

- a. Under airfield and heliport pavements, paved roads, streets, parking areas, and similar-use pavements including adjacent shoulder areas, the density shall be not less than 90 percent of maximum density for cohesive material and 95 percent of maximum density for cohesionless material, up to the elevation where requirements for pavement subgrade materials and compaction shall control.
- b. Under unpaved or turfed traffic areas, density shall not be less than 90 percent of maximum density for cohesive material and 95 percent of maximum density for cohesionless material.
- c. Under nontraffic areas, density shall be not less than that of the surrounding material.

3.7.5 Determination of Density

Testing shall be the responsibility of the Contractor and performed at no additional cost to the Government. Testing shall be performed by an approved commercial testing laboratory or by the Contractor subject to approval. Tests shall be performed in sufficient number to ensure that specified density is being obtained. Laboratory tests for moisture-density relations shall be made in accordance with [ASTM D 1557](#) except that mechanical tampers may be used provided the results are correlated with those obtained with the specified hand tamper. Field density tests shall be determined in accordance with [ASTM D 2167](#) or [ASTM D 6938](#). When [ASTM D 6938](#) is used, the calibration curves shall be checked and adjusted, if necessary, using the sand cone method as described in paragraph Calibration of the referenced publications. [ASTM D 6938](#) results in a wet unit weight of soil and [ASTM D 6938](#) shall be used to determine the moisture content of the soil. The calibration curves furnished with the moisture gauges shall be checked along with density calibration checks as described in [ASTM D 6938](#). Test results shall be furnished the Contracting Officer. The calibration checks of both the density and moisture gauges shall be made at the beginning of a job on each different type of material encountered and at intervals as directed.

3.8 PIPELINE TESTING

3.8.1 Leakage Tests

Lines shall be tested for leakage by low pressure air or water testing or exfiltration tests, as appropriate. Low pressure air testing for vitrified clay pipes shall conform to [ASTM C 828](#). Low pressure air testing for concrete pipes shall conform to [ASTM C 924](#). Low pressure air testing for plastic pipe shall conform to [ASTM F 1417](#). Low pressure air testing

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procedures for other pipe materials shall use the pressures and testing times prescribed in [ASTM C 828](#) or [ASTM C 924](#), after consultation with the pipe manufacturer. Testing of individual joints for leakage by low pressure air or water shall conform to [ASTM C 1103](#). Prior to exfiltration tests, the trench shall be backfilled up to at least the lower half of the pipe. If required, sufficient additional backfill shall be placed to prevent pipe movement during testing, leaving the joints uncovered to permit inspection. Visible leaks encountered shall be corrected regardless of leakage test results. When the water table is [2 feet](#) or more above the top of the pipe at the upper end of the pipeline section to be tested, infiltration shall be measured using a suitable weir or other device acceptable to the Contracting Officer. An exfiltration test shall be made by filling the line to be tested with water so that a head of at least [2 feet](#) is provided above both the water table and the top of the pipe at the upper end of the pipeline to be tested. The filled line shall be allowed to stand until the pipe has reached its maximum absorption, but not less than 4 hours. After absorption, the head shall be reestablished. The amount of water required to maintain this water level during a 2-hour test period shall be measured. Leakage as measured by the exfiltration test shall not exceed [0.2 gallons per inch in diameter per 100 feet](#) of pipeline per hour. When leakage exceeds the maximum amount specified, satisfactory correction shall be made and retesting accomplished.

3.8.2 Deflection Testing

Perform a deflection test on entire length of installed plastic pipeline on completion of work adjacent to and over the pipeline, including leakage tests, backfilling, placement of fill, grading, paving, concreting, and any other superimposed loads. Deflection of pipe in the installed pipeline under external loads shall not exceed 4.5 percent of the average inside diameter of pipe. Determine whether the allowable deflection has been exceeded by use of a pull-through device or a deflection measuring device.

a. Pull-through device: This device shall be a spherical, spheroidal, or elliptical ball, a cylinder, or circular sections fused to a common shaft. Circular sections shall be so spaced on the shaft that distance from external faces of front and back sections will equal or exceed diameter of the circular section. Pull-through device may also be of a design promulgated by the Uni-Bell Plastic Pipe Association, provided that the device meets the applicable requirements specified in this paragraph, including those for diameter of the device. Ball, cylinder, or circular sections shall conform to the following:

- 1 A diameter, or minor diameter as applicable, of 95 percent of the average inside diameter of the pipe; tolerance of plus 0.5 percent will be permitted.

- 2 A homogeneous material throughout, with a density greater than 1.0 as related to water at [39.2 degrees F](#), and a surface Brinell hardness of not less than 150.

- 3 Center bored and through bolted with a [1/4 inch](#) minimum diameter steel shaft having a yield strength of not less than [70,000 psi](#), with eyes or loops at each end for attaching pulling cables.

- 4 Each eye or loop shall be suitably backed with a flange or heavy washer such that a pull exerted on opposite end of shaft will produce compression throughout remote end.

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b. Deflection measuring device: Sensitive to 1.0 percent of the diameter of the pipe being tested and accurate to 1.0 percent of the indicated dimension. Deflection measuring device shall be approved by the Contracting Officer prior to use.

c. Pull-through device: Pass the pull-through device through each run of pipe, either by pulling it through or flushing it through with water. If the device fails to pass freely through a pipe run, replace pipe which has the excessive deflection and completely retest in same manner and under same conditions as specified.

d. Deflection measuring device procedure: Measure deflections through each run of installed pipe. If deflection readings in excess of 4.5 percent of average inside diameter of pipe are obtained, retest pipe by a run from the opposite direction. If retest continues to show a deflection in excess of 4.5 percent of average inside diameter of pipe, remove pipe which has excessive deflection, replace with new pipe, and completely retest in same manner and under same conditions.

e. Warranty period test: Pipe found to have a deflection of greater than 5 percent of average inside diameter when deflection test is performed just prior to end of one-year warranty period shall be replaced with new pipe and tested as specified for leakage and deflection.

-- End of Section --

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SECTION 33 46 16

SUBDRAINAGE SYSTEM

04/08

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A 123/A 123M	(2002) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 27/A 27M	(2005) Standard Specification for Steel Castings, Carbon, for General Application
ASTM A 47/A 47M	(1999; R 2004) Standard Specification for Steel Sheet, Aluminum-Coated, by the Hot-Dip Process
ASTM A 48/A 48M	(2003) Standard Specification for Gray Iron Castings
ASTM C 139	(2005) Standard Specification for Concrete Masonry Units for Construction of Catch Basins and Manholes
ASTM C 231	(2004) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 478	(2007) Standard Specification for Precast Reinforced Concrete Manhole Sections
ASTM D 1751	(2004) Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D 1752	(2004a) Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion
ASTM D 2751	(2005) Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings
ASTM D 3034	(2006) Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings

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ASTM D 3212	(1996a; R 2003e1) Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM D 5034	(1995; R 2001) Breaking Strength and Elongation of Textile Fabrics (Grab Test)
ASTM F 405	(2005) Corrugated Polyethylene (PE) Tubing and Fittings
ASTM F 667	(2006) Large Diameter Corrugated Polyethylene Pipe and Fittings
ASTM F 949	(2006a) Poly(Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings

1.2 SUBMITTALS

GSubmit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-04 Samples

Filter Fabric Pipe for Subdrains

Samples of filter fabric, pipe, and pipe fittings, before starting the work.

SD-07 Certificates

Filter Fabric Pipe for Subdrains

Certifications from the manufacturers attesting that materials meet specification requirements. Certificates are required for drain pipe, drain tile, fittings, and filter fabric.

1.3 DELIVERY, STORAGE, AND HANDLING

1.3.1 Delivery and Storage

Inspect materials delivered to site for damage; unload, and store with minimum handling. Do not store materials directly on the ground. The inside of pipes and fittings shall be free of dirt and debris. Keep, during shipment and storage, filter fabric wrapped in burlap or similar heavy duty protective covering. The storage area shall protect the fabric from mud, soil, dust, and debris. Filter fabric materials that are not to be installed immediately shall not be stored in direct sunlight. Install plastic pipe within 6 months from the date of manufacture unless otherwise approved.

1.3.2 Handling

Handle materials in such a manner as to ensure delivery to the trench in sound undamaged condition. Pipe shall be carried and not dragged to the trench.

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PART 2 PRODUCTS

2.1 PIPE FOR SUBDRAINS

Pipe for subdrains shall be of the types and sizes indicated.

2.1.1 Perforated Corrugated aluminum AlloySub Title

TextPerforated corrugated aluminum alloy pipe shall conform to ASTM B 745/B 745M, Type III, Class 1. Sheet thickness of pipe shall be as indicated.

2.1.2 Plastic

Plastic pipe shall contain ultraviolet inhibitor to provide protection from exposure to direct sunlight.

2.1.2.1 Acrylonitrile-Butadiene-Styrene (ABS)

Acrylonitrile-butadiene-styrene (ABS) piping and fittings shall conform to ASTM D 2751, with maximum SDR of 35.

2.1.2.2 Polyvinyl Chloride (PVC) and Fittings

Polyvinyl chloride (PVC) pipe and fittings shall conform to ASTM D 3034 and ASTM F 949.

2.1.2.3 Corrugated Polyethylene (PE) and Fittings

Use ASTM F 405 for pipes 3 to 6 inches in diameter, inclusive, ASTM F 667 for pipes 8 to 24 inches in diameter. Fittings shall be manufacturer's standard type and shall conform to the indicated specification.

2.1.2.4 Pipe Perforations

Water inlet area shall be a minimum of 0.5 square inch per linear foot. Manufacturer's standard perforated pipe which essentially meets these requirements may be substituted with prior approval of the Contracting Officer.

a. Circular Perforations in Plastic Pipe: Circular holes shall be cleanly cut not more than 3/8 inch or less than 3/16 inch in diameter and arranged in rows parallel to the longitudinal axis of the pipe. Perforations shall be approximately 3 inches center-to-center along rows. The rows shall be approximately 1-1/2 inches apart and arranged in a staggered pattern so that all perforations lie at the midpoint between perforations in adjacent rows. The rows shall be spaced over not more than 155 degrees of circumference. The spigot or tongue end of the pipe shall not be perforated for a length equal to the depth of the socket, and perforations shall continue at uniform spacing over the entire length of the pipe.

b. Slotted Perforations in Plastic Pipe: Circumferential slots shall be cleanly cut so as not to restrict the inflow of water and uniformly spaced along the length and circumference of the tubing. Width of slots shall not exceed 1/8 inch nor be less than 1/32 inch. The length of individual slots shall not exceed 1-1/4 inches on 3 inch diameter tubing, 10 percent of the tubing inside nominal circumference on 4 to 8 inch diameter tubing, and 2-1/2 inches on 10 inch diameter tubing. Rows of slots shall be symmetrically spaced so that they are fully

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contained in 2 quadrants of the pipe. Slots shall be centered in the valleys of the corrugations of profile wall pipe.

2.2 FILTER FABRIC

Filter fabric shall be a pervious sheet of polyester, nylon, or polypropylene filaments woven or otherwise formed into a uniform pattern with distinct and measurable openings. The filter fabric shall provide an equivalent opening size (AOS) no finer than the US Standard Sieve No. 120 and no coarser than the US Standard Sieve No. 170. AOS is defined as the number of the US Standard sieve having openings closest in size to the filter fabric openings. The fabric shall have a minimum physical strength of 100 pounds per inch in any direction when tested in accordance with ASTM D 5034 using the grab test method with 1 square inch jaws and a constant rate of travel of 12 inches per minute. Elongation at failure shall be between 30 and 70 percent. The fabric shall be constructed so that the filaments will retain their relative position with respect to each other. The edges of the fabric shall be selvaged or otherwise finished to prevent the outer material from pulling away from the fabric.

2.3 DRAINAGE STRUCTURES

2.3.1 Concrete

The concrete mixtures shall have air content, by volume of concrete, based on measurements made immediately after discharge from the mixer of 5 to 7 percent when coarse-aggregate maximum size is 1-1/2 inches or smaller. Air content shall be determined in accordance with ASTM C 231. The concrete covering over steel reinforcing shall be not less than 1 inch thick for covers and not less than 1-1/2 inches thick for walls and flooring. Concrete covering deposited directly against the ground shall be at least 3 inches thick between the steel and the ground. Expansion-joint filler material shall conform to ASTM D 1751 or ASTM D 1752. Exposed concrete surfaces, such as drainage structures that form a continuation of concrete curbs and gutters, shall be given a protective coating of linseed oil as specified in Section 32 16 13 CONCRETE SIDEWALKS AND CURBS AND GUTTERS.

2.3.2 Mortar

Mortar for pipe joints and connections to other drainage structures shall be composed of one part by volume of portland cement and two parts of sand. The quantity of water in the mixture shall be sufficient to produce a stiff workable mortar. Water shall be clean and free of injurious acids, alkalies, and organic impurities. The mortar shall be used within 30 minutes from the time the ingredients are mixed with water.

2.3.3 Manholes and Appurtenances

2.3.3.1 Precast Reinforced Concrete Manhole Risers and Tops

Precast reinforced concrete manhole risers and tops shall be manufactured in accordance with Section 03 40 00.00 10 PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION and conform to ASTM C 478.

2.3.3.2 Precast Concrete Segmental Blocks

Precast concrete segmental blocks shall conform to ASTM C 139 and shall be not more than 8 inches thick, not less than 8 inches long, and of such shape that the joints can be effectively sealed and bonded with cement

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mortar.

2.3.3.3 Precast Concrete Manhole Bases

If precast concrete manhole bases are used, the bases shall be manufactured in accordance with Section 03 40 00.00 10 PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION and conform to ASTM C 478 and shall be of such a design as to effect suitable connection with influent and effluent lines and to provide a suitable base structure for riser sections.

2.3.3.4 Frames and Covers or Gratings

Frames and gratings, or frames and covers, except as otherwise permitted, shall be of either cast iron with tensile strength test not less than ASTM A 48/A 48M Class 25 or steel conforming to ASTM A 27/A 27M, Class 65-35. Weight, shape, and size shall be as indicated. Frames and covers not subjected to vehicular traffic or storage may be of malleable iron where indicated. The malleable-iron frames and covers shall conform to ASTM A 47/A 47M and shall be of the weight, shape, and size indicated.

2.3.3.5 Steel Ladder

A steel ladder shall be provided where the depth of a manhole exceeds 12 feet. The ladder will be not less than 16 inches in width, with 3/4 inch diameter rungs spaced 12 inches apart. The two stringers shall be a minimum 3/8 inch thick and 2 inches wide. Ladder shall be adequately anchored to the wall by means of steel inserts spaced not more than 6 feet apart vertically, and shall be so installed as to provide at least 6 inches of space between the wall and the rungs. Ladders and inserts shall be galvanized after fabrication in conformance with ASTM A 123/A 123M. The wall along the line of the ladder shall be vertical for its entire length.

PART 3 EXECUTION

3.1 EXCAVATION AND BEDDING FOR SUBDRAIN SYSTEMS

Bedding material shall be placed in the trench as indicated or as required as replacement materials used in those areas where unstable materials were removed.

3.2 MANHOLES AND FLUSHING AND OBSERVATION RISERS

3.2.1 Manholes

Manholes shall be installed complete with frames and covers or gratings at the locations and within the limits and sizes indicated. Manholes shall be constructed of one of the materials specified for manholes in paragraph DRAINAGE STRUCTURES. Joints shall be completely filled and shall be smooth and free of surplus mortar or mastic on the inside of the structure. Brick manholes shall be plastered with 1/2 inch of mortar over the entire outside surface of the walls. Brick for square or rectangular structures shall be laid in stretcher courses with a header course every sixth course. Brick for round structures shall be laid radially with every sixth course laid as a stretcher course. Ladders shall be installed in manholes as indicated. Base for manholes shall be either precast or cast-in-place concrete.

3.2.2 Flushing and Observation Risers

Flushing and observation riser pipes with frames and covers shall be

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installed at the locations indicated. Risers shall be constructed of precast concrete, vitrified clay, or galvanized corrugated metal pipe. Joining of riser pipes to the subdrain system shall be as indicated.

3.3 INSTALLATION OF FILTER FABRIC AND PIPE FOR SUBDRAINS

3.3.1 Installation of Filter Fabric

3.3.1.1 Overlaps on Perforated or Slotted Pipes

One layer of filter fabric shall be wrapped around perforated or slotted collector pipes in such a manner that longitudinal overlaps of fabric are in unperforated or unslotted quadrants of the pipes. The overlap shall be at least 2 inches. The fabric shall be secured to the pipe in such a manner that backfill material will not infiltrate through any fabric overlaps.

3.3.1.2 Installation on Open-Joint Pipe

One layer of filter fabric shall be wrapped around open joints. The overlap should be at least 2 inches. The fabric shall be secured to the pipe in such a manner that backfill material will not infiltrate through the overlap or the edges of the fabric to either side of the open joint.

3.3.1.3 Trench Lining and Overlaps

Trenches to be lined with filter fabric shall be graded to obtain smooth side and bottom surfaces so that the fabric will not bridge cavities in the soil or be damaged by projecting rock. The fabric shall be laid flat but not stretched on the soil, and it shall be secured with anchor pins. Overlaps shall be at least 6 inches, and anchor pins shall be used along the overlaps.

3.3.2 Installation of Pipe for Subdrains

3.3.2.1 Pipelaying

Each pipe shall be carefully inspected before it is laid. Any defective or damaged pipe shall be rejected. No pipe shall be laid when the trench conditions or weather is unsuitable for such work. Water shall be removed from trenches by sump pumping or other approved methods. The pipe shall be laid to the grades and alignment as indicated. The pipe shall be bedded to the established gradeline. Perforations shall be centered on the bottom of the pipe. Pipes of either the bell-and-spigot type or the tongue-and-groove type shall be laid with the bell or groove ends upstream. All pipes in place shall be approved before backfilling.

3.3.2.2 Jointings

a. Nonperforated Concrete and Clay Pipe: Pipe shall be laid with 1/8 to 1/4 inch opening between the ends of the pipe or as required by spacing lugs constructed in the pipe. Mortar shall be placed in the joint at three points and pressed firmly into place to hold the pipe securely in line. The mortar shall be the full depth of the bell or groove and approximately 1 inch in width, and shall be located at the third points around the joint with the top point at the center of the pipe. The inside of the pipe shall be free of excess mortar.

b. Perforated Concrete and Clay Pipe: The pipe shall be laid with

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closed joints with positive provision for centering each section of the pipe in the bell or groove of the previously placed section. Plain-end perforated clay pipe sections shall be securely fastened together with spring wire clips furnished by the pipe manufacturer.

c. Perforated Corrugated Metal Pipe or Bituminous Coated, Perforated Corrugated Metal Pipe: The sections of perforated corrugated metal pipe or bituminous coated, perforated corrugated metal pipe shall be securely fastened together with standard connecting bands furnished by the manufacturer of the pipe.

d. Drain Tile: Drain tile shall be bedded as provided for bell-and-spigot or tongue-and-groove types of pipe and laid with open joints of approximately $\frac{1}{8}$ inch width but not over $\frac{1}{4}$ inch width. Drain tile shall be protected against the entrance of filter material into the line by the use of filter fabric.

e. Porous Concrete Pipe: Porous concrete pipe shall be installed with mortar joints.

f. Perforated Asbestos-Cement Pipe: Couplings shall be of the sleeve type suitable for holding the pipe firmly in alignment without the use of sealing compounds or gaskets. Tapered couplings will be acceptable.

g. Bituminous Coated or Uncoated Semicircular Steel Pipe: Coupling bands shall consist of an uncorrugated top and bottom section fabricated to fit around two adjacent pieces of pipe. Coupling bands shall be bolted together with four bolts.

h. Bituminous Coated or Uncoated Corrugated Aluminum Pipe: If aluminum pipe is to be connected to dissimilar metal, the connection shall be insulated by bituminous coating or other nonconductive material. Standard joints between corrugated aluminum pipe shall be securely fastened with standard connecting bands furnished by the manufacturer of the pipe.

i. Acrylonitrile-Butadiene-Styrene (ABS): Solvent cement or elastomeric joints for ABS pipe shall be in accordance with ASTM D 2751. Dimensions and tolerances shall be in accordance with TABLE II of ASTM D 2751.

j. Polyvinyl Chloride (PVC) Pipe: Joints shall be in accordance with the requirements of ASTM D 3034, ASTM D 3212, or ASTM F 949.

k. Perforated Corrugated Polyethylene Pipe: Perforated corrugated polyethylene drainage pipe shall be installed in accordance with the manufacturer's specifications and as specified herein. A pipe with physical imperfections shall not be installed. No more than 5 percent stretch in a section will be permitted.

3.4 INSTALLATION OF FILTER MATERIAL AND BACKFILLING FOR SUBDRAINS

After pipe for subdrains has been laid, inspected, and approved, filter material shall be placed around and over the pipe to the depth indicated. The filter material shall be placed in layers not to exceed 8 inches thick, and each layer shall be thoroughly compacted by mechanical tampers or rammers to obtain the required density.

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3.5 TESTS

3.5.1 Pipe Test

Strength tests of pipe shall conform to field service test requirements of the Federal Specification, ASTM specification, or AASHTO specification covering the product (paragraph PIPE FOR SUBDRAINS).

-- End of Section --

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NATURAL GAS DISTRIBUTION

04/06

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN PETROLEUM INSTITUTE (API)

- | | |
|--------------|--|
| API Spec 5L | (2007) Specification for Line Pipe |
| API Spec 6D | (2002; Errata 2005) Specification for Pipeline Valves |
| API Std 1104 | (2005; Errata 2007) Welding of Pipeline and Related Facilities |

AMERICAN WATER WORKS ASSOCIATION (AWWA)

- | | |
|-----------|---|
| AWWA C203 | (2002) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied |
|-----------|---|

ASME INTERNATIONAL (ASME)

- | | |
|-------------|---|
| ASME B16.11 | (2005) Forged Fittings, Socket-Welding and Threaded |
| ASME B16.40 | (2002; Errata 2003) Manually Operated Thermoplastic Gas Shutoffs and Valves in Gas Distribution Systems |
| ASME B16.5 | (2003) Standard for Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24 |
| ASME B16.9 | (2003) Standard for Factory-Made Wrought Steel Buttwelding Fittings |
| ASME B31.8 | (2003) Gas Transmission and Distribution Piping Systems |
| ASME PTC 25 | (2001) Pressure Relief Devices |

ASTM INTERNATIONAL (ASTM)

- | | |
|-------------------|--|
| ASTM A 135/A 135M | (2006) Standard Specification for Electric-Resistance-Welded Steel Pipe |
| ASTM A 139/A 139M | (2004) Standard Specification for Electric-Fusion (ARC)-Welded Steel Pipe (NPS 4 and over) |

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ASTM A 53/A 53M (2007) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

ASTM D 2513 (2007a) Thermoplastic Gas Pressure Pipe, Tubing, and Fittings

ASTM D 2774 (2004e1) Underground Installation of Thermoplastic Pressure Piping

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-110 (1996) Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends

MSS SP-72 (1999) Standard for Ball Valves with Flanged or Butt-Welding Ends for General Service

MSS SP-78 (2005a) Cast Iron Plug Valves, Flanged and Threaded Ends

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 3 (2004; E 2004) Power Tool Cleaning

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS A-A-58092 (Basic) Tape, Antiseize, Polytetrafluoroethylene

1.2 RELATED REQUIREMENTS

Section 23 00 00.00 98 GENERAL MECHANICAL PROVISIONS, applies to this section unless otherwise specified.

1.3 SYSTEM DISTRIBUTION

The gas distribution system includes natural gas piping and appurtenances from point of connection with existing system as indicated to a point approximately 5 feet (1.5 meters) from the buildings.

1.3.1 Gas Distribution System and Equipment Operation Data

Include maps showing piping layout, locations of system valves, gas line markers; step-by-step procedures for system start up, operation and shutdown (index system components and equipment to the system maps); isolation procedures including valve operation to shutdown or isolate each section of the system (index valves to the system maps and provide separate procedures for normal operation and emergency shutdown if required to be different).

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. When used, a designation following the "G" designation

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identifies the office that will review the submittal for the Government. The following shall be submitted:

SD-03 Product Data

Piping

Fittings

Valves

SD-07 Certificates

Welders procedures and qualifications (metal and PE)

SD-10 Operation and Maintenance Data

Gas Distribution System and Equipment Operation

1.5 QUALITY ASSURANCE

Materials and equipment shall conform to ASME B31.8 to the extent specified herein, to local utility requirements, and to other requirements specified.

1.6 DELIVERY, STORAGE, AND HANDLING

1.6.1 Delivery and Storage

Inspect materials delivered to the site for damage, and store with a minimum of handling. Store materials on site in enclosures or under protective coverings. Store plastic piping under cover out of direct sunlight. Do not store materials directly on the ground. Keep inside of pipes and fittings free of dirt and debris.

1.6.2 Handling

Handle pipe, fittings, valves, and other accessories in such manner as to ensure delivery to the trench in sound, undamaged condition. Take special care not to damage coatings on pipe and fittings. Repair damaged coatings to original finish. Handle steel piping with coal-tar enamel coating in accordance with AWWA C203.

PART 2 PRODUCTS

2.1 PIPING MATERIALS FOR GAS DISTRIBUTION MAINS

Piping shall be black steel, above grade and polyethylene (PE) below grade. Provide shutoff valves and insulating joints where indicated.

2.1.1 Steel Pipe and Fittings

API Spec 5L, Grade A, ASTM A 53/A 53M, Grade A, ASTM A 135/A 135M, or ASTM A 139/A 139M, Grade A, Schedule 40. Butt weld fittings shall be wrought steel, ASME B16.9, Schedule 40. Socket weld and threaded fittings shall be forged steel, ASME B16.11.

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2.1.1.1 Joints and Jointing Materials

Pipe and fittings shall have welded joints except as otherwise indicated or specified.

2.1.1.2 Welded Joints

Electrodes, joint design, welders procedures and qualifications (metal and PE), and weld examination and testing shall conform to API Std 1104.

2.1.1.3 Flanged Joints

Steel flanges shall conform to ASME B16.5, Class 150. Steel flanges that are to be connected to cast iron flanges shall be flat face construction. Provide raised face steel flanges for pipe-to-pipe connections and connections to flanged steel valves. Bolts, nuts, and gaskets shall conform to ASME B31.8.

2.1.2 Plastic Pipe, Fittings, Joints, and Jointing Materials

2.1.2.1 Thermoplastic (Polyethylene - PE)

PE pipe and heat fusion fittings shall conform to ASTM D 2513, Grade PE2406 or PE3408, DR 11. Pipe and fittings shall have heat fusion welded joints. PE pipe and fitting materials for heat fusion shall be compatible to ensure uniform melting and a proper bond.

2.2 PIPING MATERIALS FOR GAS SERVICE LINES

2.2.1 Steel Pipe, Fittings, Joints and Jointing Materials

Threaded fittings shall be black malleable iron or steel. Pipe and fittings shall have welded joints. Do not use threaded joints except where indicated.

2.2.2 PE Pipe and Heat Fusion Fittings

Conform to ASTM D 2513. Minimum wall thickness shall be as specified in ASTM D 2513. PE pipe and fittings shall have joints as specified for gas distribution main piping.

2.3 GAS MAIN VALVES AND ACCESSORIES

2.3.1 Shut-Off Valves

Manually operated shut-off valves for gas distribution main and regulator station piping with a minimum pressure rating of 150 psig.

2.3.1.1 Plug Valves

API Spec 6D for steel valves or MSS SP-78 for cast iron valves. Valves shall be full bore type. Minimum bore size for full bore valves shall be 95percent of the internal cross sectional area of pipe of the same nominal diameter. Steel valves installed on buried steel piping shall have butt-welding ends. Steel valves installed on buried RTR PE piping shall have flanged ends. \Cast iron valves installed on buried steel RTR PE piping shall have flanged ends. Valves not on buried piping shall have ends as indicated. Plug valves shall be lubricated. Lubricating fittings on installed valves shall be accessible for relubrication, or extensions shall

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be provided to make them accessible. Plug valves shall be wrench or gear operated. Wrench operated valves shall have a 2 inch square adaptor securely fastened to the valve stem. Maximum allowable operating torque in foot-pounds shall be limited to:

<u>Nominal Valve Size (Inches)</u>	<u>Torque (Foot-Pounds)</u>
2	25

2.3.1.2 Ball Valves

API Spec 6D or MSS SP-72 or MSS SP-110. Provide valve body material of carbon steel for installation on steel pipe, and ductile iron for installation on plastic pipe. Valves shall be full bore type. Minimum bore size for full bore valves shall be 95 percent of the internal cross sectional area of pipe of the same nominal diameter. Valves used on buried PE mains shall have flanged ends. Valves not on buried piping shall have ends as indicated. Ball valves shall be wrench or gear operated. Wrench operated valves shall have a 2 inch square adaptor securely fastened to the valve stem. Maximum allowable operating torque in foot-pounds shall be limited to:

<u>Nominal Valve Size (Inches)</u>	<u>Torque (Foot-Pounds)</u>
2	40

2.3.1.3 Below Ground Polyethylene Valves

ASME B16.40. Provide PE valves only with underground PE piping.

2.3.2 Gas Regulator Station

Includes regulator valves, relief valve, strainer, meter, regulator by-pass piping, and plug or ball type shut-off valves as indicated. Regulator station piping and above grade piping from buried gas lines to the regulator station shall be steel piping as specified for gas distribution main piping. Regulator station piping, fittings and valves shall be welded joint except where flanged joints are indicated. Pipe and equipment supports shall be of non-combustible material. Regulator station shall be located aboveground as indicated.

2.3.2.1 Regulator Valve

Steel or ductile-iron body, flanged ends for sizes 2 1/2 inches and larger and threaded ends for sizes 2 inches and smaller. Regulator valve shall conform to indicated size, capacity, and reduction of indicated pressure requirements. Provide overpressure protection to prevent gas pressure from exceeding the indicated value in accordance with ASME B31.8.

2.3.2.2 Pressure Relief Valve

Provide to prevent gas pressure from exceeding the indicated value, have sufficient capacity to prevent overpressuring the system, and be adjusted to ensure that a pressure increase shall not cause unsafe operation of

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connected and properly adjusted gas utilization equipment in a low-pressure distribution system. Each pressure relief valve shall meet the performance standards set forth in ASME PTC 25, and shall be steel or cast iron.

2.3.2.3 Strainer

Provide to remove particulate matter from the gas stream and have a steel or cast iron housing with a removable stainless steel strainer basket with a mesh sized to remove particles that would interfere with regulator valve operation.

2.3.3 Valve Boxes

Provide each valve on buried piping with a plastic or cast-iron valve box of a size suitable for the valve. Valve box shall have a round cover with the word "Gas" cast on it. Valve boxes shall be provided with lock-type covers that require a special wrench for removing. Each cast-iron box shall be given a heavy coat of bituminous paint.

2.4 GAS SERVICE LINE VALVES AND ACCESSORIES

2.4.1 Valves

Provide plug or ball valves for service lines as specified for gas main valves.

2.4.2 Valve Boxes for Curb Cocks

Provide each valve on buried piping with a valve box as specified for gas main valves. Provide 60 cm x 60 cm concrete collar at grade.

PART 3 EXECUTION

3.1 LOCATION OF GAS LINES

Do not install gas piping in the same trench with other utilities. The minimum horizontal clearance between gas pipe and parallel utility pipe shall be 2 feet (1 meter). Do not install gas pipe through catch basins, vaults, manholes or similar underground structures.

3.2 VERIFICATION OF CONDITIONS

Pipe, fittings, valves and accessories will be carefully inspected by the Contracting Officer or the Contracting Officer's authorized representative before and after installation and those found defective will be rejected. Pipe and fittings shall be free from fins and burrs. Before being placed in position, clean pipe, fittings, valves, and accessories and maintain in a clean condition.

3.3 INSTALLATION OF PIPELINES

3.3.1 Pipe Laying and Jointing

Provide proper facilities for lowering sections of pipe into trenches. Cut pipe accurately to measurements established at the site and work into place without springing or forcing. Replace pipe or fittings that do not allow sufficient space for proper installation of jointing material with pipe or fittings of proper dimensions. Grade pipe in straight lines, taking care to avoid the formation of dips and low points. Support pipe at proper

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elevation and grade, taking care to secure firm and uniform support. Wood support blocking will not be permitted. The full length of each section of pipe and all fittings shall rest solidly on the pipe bed, with recesses excavated to accommodate joints and couplings. Provide anchors and supports where indicated. Make provision for the expansion and contraction of pipe lines as indicated. Keep trenches free of water until joints have been made. Close open ends of pipe temporarily with wood blocks or plastic end closures at the end of each work day. Gas mains shall have a minimum earth cover of **30 inches** (75 centimeters) except that in rock excavation, minimum earth cover shall be **24 inches**.

3.3.2 Buried Warning and Identification Tape

Provide yellow detectable tape over full extent of buried gas line.

3.3.3 Connections to Existing Pipelines

When it is necessary to make connections to live gas mains, use pressure tight installation equipment. Connections shall be made in accordance with **ASME B31.8**.

3.3.4 Installation of Valves for Gas Mains

Install valves in accordance with applicable installation requirements specified in **ASME B31.8** and as indicated. Install valve stems on buried piping vertically with a minimum of **8 inches** clearance from stem top to finished grade. Valves installed in PE piping shall be restrained as indicated so that no turning torque is transmitted to the pipe.

3.3.5 Earthwork

Earthwork shall be in accordance with Section 31 23 02.98 EXCAVATION, BACKFILL AND COMPACTING FOR UTILITIES. Employ hand excavation within 5 feet (1.5 meters) of existing gas pipelines or other underground structures. Do not damage pipe coating during earthwork operations.

3.3.5.1 Steel Gas Main Piping Joints

Weld joints. Make welded joints in accordance with **ASME B31.8** and **API Std 1104**. Welders qualifications, welding procedures and weld examinations shall be in accordance with **API Std 1104**. Make flanged joints up tight, taking care to avoid undue strain on valves, fittings, and other accessories. Align bolt holes for each flanged joint. Install full-size bolts for bolt holes; installation of undersized bolts to make up for misalignment of bolt holes or for other purposes will not be permitted. Adjoining flange faces shall not be out of parallel to such degree that flanged joint cannot be made gas-tight without overstraining the flange. Faces of flanges and bolt and nut bearing areas shall be clean and smooth. Replace flanged pipe or fittings whose dimensions do not allow for making a proper flanged joint as specified herein with one of proper dimensions. Make up joints between ferrous and nonferrous metallic piping with insulating fittings. Threaded joints shall have tapered threads, evenly cut, and be made with Underwriter's Laboratories approved graphite compound for gas service or with polytetrafluoroethylene tape conforming to **FS A-A-58092**, applied to the male threads only. After cutting and before threading, ream pipe and remove burrs. Calking of threaded joints to stop or prevent leaks will not be permitted.

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3.3.6 Special Requirements for PE Gas Main Piping Installation

Install pipelines as specified herein and in accordance with the applicable requirements of [ASME B31.8](#).

3.3.6.1 Placement

Install a No. 10 gage copper tracer wire with buried PE pipe to facilitate location with an electronic detector. Install wire [8 to 12 inches](#) (18 to 45 centimeters) above pipeline and terminate [3 to 4 inches](#) (10 centimeters) above grade. Do not wrap wire around pipe.

3.3.6.2 Earthwork for Plastic Gas Main Piping

Earthwork shall be in accordance Section 31 23 02.98 EXCAVATION, BACKFILL AND COMPACTING FOR UTILITIES. Where practicable, plastic pipe and tubing shall be under an internal pressure of [15 psig](#) during backfill operations. Employ hand excavation within [5 feet](#) of existing gas pipelines or other underground structures.

3.3.6.3 Plastic Gas Main Piping Joints

Make joints for PE pipe or tubing and fittings in accordance with [ASME B31.8](#) and the recommendations of the manufacturer of the pipe or tubing and fittings.

3.3.7 Special Requirements for Gas Service Piping Installation

Work shall include the connection to the building piping where the building piping has been installed. Where building piping has not been installed, terminate service lines with a temporary cap approximately [five feet](#) (1.5 meters) from the building line at a point directed by the Contracting Officer or the Contracting Officer's authorized representative. Installation shall be in accordance with the applicable requirements of [ASME B31.8](#). Installation of PE pipe or tubing shall further be in accordance with the applicable requirements of [ASTM D 2774](#). Minimum earth cover for service lines shall be [24 inches](#) (60 centimeters) in streets or roads and [12 inches](#) 300 mm in private property. Install an electrically conductive No. 10 gage wire with buried PE pipe or tubing to facilitate location with an electronic detector. Install wire [6 to 8 inches](#) 150 to 200 mm above service line and terminate [3 to 4 inches](#) 080 mm to 100 mm above grade. Do not wrap wire around pipe.

3.3.7.1 Earthwork for Gas Service Piping

Earthwork shall be in accordance with Section 31 23 02.98 EXCAVATION, BACKFILLING AND COMPACTING FOR UTILITIES, and for PE pipe or tubing the applicable requirements of [ASTM D 2774](#). Employ hand excavation within [5 feet](#) (1.5 meters) of existing gas pipelines or other underground structures.

3.3.7.2 Service Connections

Make service connections at the top of the main, whenever the depth of the main is sufficient to allow top connections. When service connections cannot be made at the top of the main, they shall be made on the side of the main as close to the top as possible. Service connections shall not be made lower than the horizontal midpoint of the gas main. Install service connections in accordance with the applicable requirements of [ASME B31.8](#).

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3.3.7.3 Gas Service Piping Joints

- a. Steel Pipe: Make joints for steel service line piping as specified for steel distribution main piping.
- b. PE Pipe or Tubing: Make joints for PE pipe or tubing and fittings in accordance with ASME B31.8 and the recommendations of the manufacturer of the pipe or tubing and fittings.

3.3.7.4 Valve Installation on PE Service Lines

Restrain curb cocks installed on PE service lines as indicated so that no turning torque can be transmitted to the pipe. Support curb boxes as indicated.

3.4 PROTECTION AGAINST CORROSION (FIELD APPLIED)

3.4.1 Corrosion Protection Systems

Valves and other metallic components installed on buried plastic piping shall be shop coated and protected with a grounding wire extended full length of the plastic line and connected to all metallic components and a ground rod. Paint metallic piping, fittings, and accessories aboveground and in vaults. Electrically isolate metallic pipe from other underground metallic structures, including metallic casings. After completing pressure tests, wrap joints and damaged areas of shop coatings with plastic tape as specified in paragraph entitled "Application of Plastic Tape," or coat using material and procedures recommended by the manufacturer of the pipe shop-coating.

3.4.2 Painting

Exposed metal gas piping, valves, and other accessories not specified as being shop coated or otherwise finished shall be cleaned in accordance with SSPC SP 3, primed and finish painted with two coats of waterbased enamel, color, yellow. Touch up damaged shop coatings as required to restore them to original finish.

3.5 FIELD QUALITY CONTROL

Do not coat, bury, cover or conceal joints and fittings until they have been inspected, tested and approved.

3.5.1 Inspection of Welds

Inspect quality of welded joints visually on a sampling basis. Repair defective welds or remove from the line and reweld piping.

3.5.2 Piping Strength and Tightness Tests

Test gas distribution system piping for leaks with air at 100 psig after construction and before being placed in service. Disconnect piping under test from live gas piping systems. Where possible, test main and service pipe as a unit. Service line connections, and pipe joints which are not included in the pressure test shall be given a leakage test at normal operating pressure after the piping system is placed in operation. Maintain a permanent written record of pressure test performed.

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3.6 PURGING LINES

Purge mains and service lines before placing in service in accordance with ASME B31.8.

3.7 FINAL CLEAN-UP

Upon completion of the work, remove and dispose of excess spoil and leave the areas in a clean condition. Restore service line trenches as nearly as possible to the original appearance and condition.

-- End of Section --

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ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND 10/07

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A 48/A 48M	(2003) Standard Specification for Gray Iron Castings
ASTM C 478	(2007) Standard Specification for Precast Reinforced Concrete Manhole Sections
ASTM C 478M	(2007) Standard Specification for Precast Reinforced Concrete Manhole Sections (Metric)

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(2007; Errata 2007) National Electrical Safety Code
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NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA TC 6 & 8	(2003) Standard for Polyvinyl Chloride PVC Plastic Utilities Duct for Underground Installations
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NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2007) National Electrical Code
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UNDERWRITERS LABORATORIES (UL)

UL 651	(2005; Rev thru May 2007) Standard for Schedule 40 and 80 Rigid PVC Conduit and Fittings
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1.2 GENERAL REQUIREMENTS

1.3 SUBMITTALS

PART 2 PRODUCTS

2.1 STANDARD PRODUCT

Material and equipment shall be the standard product of a manufacturer regularly engaged in the manufacture of the product and shall essentially duplicate items that have been in satisfactory use for at least 2 years

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prior to bid opening. Items of the same classification shall be identical including equipment, assemblies, parts, and components.

2.2 CONDUIT AND DUCTS

Duct lines shall be concrete-encased for duct lines between manholes and for other medium-voltage lines, Low-voltage lines and Communication lines

2.2.1 Nonmetallic Ducts

2.2.1.1 Concrete Encased Ducts

UL 651 Schedule 40 or NEMA TC 6 & 8 Type EB.

2.2.2 Conduit Sealing Compound

Compounds for sealing ducts and conduit shall have a putty-like consistency workable with the hands at temperatures as low as 35 degrees F, shall neither slump at a temperature of 300 degrees F, nor harden materially when exposed to the air. Compounds shall adhere to clean surfaces of fiber or plastic ducts; metallic conduits or conduit coatings; concrete, masonry, or lead; any cable sheaths, jackets, covers, or insulation materials; and the common metals. Compounds shall form a seal without dissolving, noticeably changing characteristics, or removing any of the ingredients. Compounds shall have no injurious effect upon the hands of workmen or upon materials.

2.3 MANHOLES, HANDHOLES, AND PULLBOXES

Manholes, handholes, and pullboxes shall be as indicated. Strength of manholes, handholes, and pullboxes and their frames and covers shall conform to the requirements of IEEE C2. Precast-concrete manholes shall have the required strength established by ASTM C 478, ASTM C 478M. Frames and covers shall be made of gray cast iron and a machine-finished seat shall be provided to ensure a matching joint between frame and cover. Cast iron shall comply with ASTM A 48/A 48M, Class 30B, minimum. Handholes for low voltage cables installed in parking lots, sidewalks, and turfed areas shall be fabricated from an aggregate consisting of sand and with continuous woven glass strands having an overall compressive strength of at least 10,000 psi and a flexural strength of at least 5,000 psi. Pullbox and handhole covers in sidewalks, and turfed areas shall be of the same material as the box. Concrete pullboxes shall consist of precast reinforced concrete boxes, extensions, bases, and covers.

Handhole and pullbox covers shall be embossed with a legend describing the type of system as defined on the Drawings. All units shall be UL listed for the intended installation, and shall be open bottom to facilitate drainage.

Handholes, pullboxes and covers are required to conform to all test provisions of the most current ANSI/SCTE 77 "Specification For Underground Enclosure Integrity" for Tier 15 applications. All covers are required to have the Tier level rating embossed on the surface. In no assembly can the cover design load exceed the design load of the box. All components in an assembly (box & cover) are manufactured using matched surface tooling. Independent third party verification or test reports stamped by a registered Professional Engineer certifying that all test provisions of this specification have been met are required with each submittal.

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PART 3 EXECUTION

3.1 DUCT LINES

3.1.1 Concrete Encasement

Ducts requiring concrete encasements shall comply with NFPA 70, except that electrical duct bank configurations for ducts 6 inches in diameter shall be determined by calculation and as shown on the drawings. The separation between adjacent electric power and communication ducts shall conform to IEEE C2. Duct line encasements shall be monolithic construction. Where a connection is made to a previously poured encasement, the new encasement shall be well bonded or doweled to the existing encasement. The Contractor shall submit proposed bonding method for approval in accordance with the detail drawing portion of paragraph SUBMITTALS. At any point, tops of concrete encasements shall be not less than the cover requirements listed in NFPA 70. Separators or spacing blocks shall be made of steel, concrete, plastic, or a combination of these materials placed not farther apart than 4 feet on centers. Ducts shall be securely anchored to prevent movement during the placement of concrete and joints shall be staggered at least 6 inches vertically.

3.1.2 Installation of Couplings

Joints in each type of duct shall be made up in accordance with the manufacturer's recommendations for the particular type of duct and coupling selected and as approved.

3.1.2.1 Plastic Duct

Duct joints shall be made by brushing a plastic solvent cement on insides of plastic coupling fittings and on outsides of duct ends. Each duct and fitting shall then be slipped together with a quick 1/4-turn twist to set the joint tightly.

3.1.3 Duct Line Markers

Duct line markers shall be provided as indicated. In addition to markers, a 5 mil brightly colored plastic tape, not less than 3 inches in width and suitably inscribed at not more than 10 feet on centers with a continuous metallic backing and a corrosion-resistant 1 mil metallic foil core to permit easy location of the duct line, shall be placed approximately 12 inches above duct banks.

3.2 PULLBOXES

3.2.1 Pullboxes

Pullbox tops shall be flush with sidewalks or curbs or placed 1/2 inch above surrounding grades when remote from curbed roadways or sidewalks. Covers shall be marked provided with 2 lifting eyes and 2 hold-down bolts. Each box shall have a suitable opening for a ground rod. Conduit, cable, ground rod entrances, and unused openings shall be sealed with mortar.

-- End of Section --

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SECTION 34 71 13.19

ACTIVE VEHICLE BARRIERS

04/08

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS
(AASHTO)

AASHTO HB-17 (2002; Errata 2003; Errata 2005) Standard
Specifications for Highway Bridges

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M (2006; Errata 2006) Structural Welding
Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A 106/A 106M (2006a) Standard Specification for
Seamless Carbon Steel Pipe for
High-Temperature Service

ASTM D 3034 (2006) Standard Specification for Type PSM
Poly(Vinyl Chloride) (PVC) Sewer Pipe and
Fittings

ASTM F 2656 (2007) Standard Test Method for Vehicle
Crash Testing of Perimeter Barriers

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250 (2003) Enclosures for Electrical Equipment
(1000 Volts Maximum)

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE J517 (2007) Hydraulic Hose

U.S. DEPARTMENT OF STATE (SD)

SD-STD-02.01 (2003; Rev A) Specification For Vehicle
Crash Test of Perimeter Barriers and Gates

U.S. FEDERAL HIGHWAY ADMINISTRATION (FHWA)

MUTCD (2000) Manual of Uniform Traffic Control
Devices

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U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910

Occupational Safety and Health Standards

UNDERWRITERS LABORATORIES (UL)

UL 486A-486B

(2003; Rev thru Aug 2006) Standard for
Wire Connectors

1.2 SYSTEM DESCRIPTION

Barrier systems used must be listed in either the Department of State (DoS) certified or Department of Defense (DoD) approved anti-ram vehicle barrier lists. Barrier widths shall be 'as certified/approved' on these lists. Alternatively, if a barrier system's width is between the widths of two listed barrier systems that are identical except for their widths, then that barrier system is also acceptable. Exceptions and acceptable widths will only be taken from the DoD anti-ram vehicle barrier list. The design and structural materials of the vehicle barrier furnished shall be the same as those used in the crash tested barrier. Crash test must have been performed and data compiled by an approved independent testing agency in accordance with either ASTM F 2656 or SD-STD-02.01. Barriers tested and certified on the previous Department of State standard, SD-STD-02.01, April 1985, and listed on the DoD approved anti-ram vehicle barrier list are also acceptable.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation; G
Equipment; G
Electrical Work; G

Detail drawings containing complete wiring and schematic diagrams, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Show on the Drawings proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including foundation and clearances for maintenance and operation. Include with the Detail drawings a copy of the Department of State certificate of barrier performance.

SD-03 Product Data

Barrier Systems

A complete list of equipment, materials, including industrial standards used and how they apply to the applicable component and manufacturer's descriptive data and technical literature, catalog cuts, and installation instructions. Information necessary to

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document a minimum 1-year successful field operation performance history for each type of vehicle barrier installed.

Spare Parts

Spare parts data for each different item of material and equipment used, after approval of the detail drawings. Include in the data a complete list of parts and supplies, with current unit prices and source of supply.

SD-06 Test Reports

Field Testing

Test reports in booklet form showing all field tests, including component adjustments and demonstration of compliance with the specified performance criteria, upon completion and testing of the installed system. Indicate with each test report the final position of controls.

SD-10 Operation and Maintenance Data

Barrier Systems; G Operating and Maintenance Instructions

Six copies of operation and maintenance manuals, a minimum of 2 weeks prior to field training. One complete set prior to performance testing and the remainder upon acceptance. Manuals shall be approved prior to acceptance. Operation manuals shall outline the step-by-step procedures required for system startup, operation, and shutdown. The manuals shall include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. Maintenance manuals shall include routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guide. The manuals shall include piping layout, equipment layout, and simplified wiring and control diagrams of the system as installed. The manuals shall also include synthetic biodegradable hydraulic oil types to be used for ambient temperature ranges of minus 30 degrees F to 150 degrees F to cover winter operation, summer operation, and ambient temperature ranges in between.

1.4 DELIVERY, STORAGE, AND HANDLING

Protect components placed in storage from the weather, humidity, and temperature variation, dirt and dust, or other contaminants. Store structural materials on sleepers or pallets and protect them from rust and objectionable materials such as dirt, grease, or oil.

1.5 EXTRA MATERIALS

Provide a manufacturer's standard recommended spare parts package, with current unit prices and source of supply complete with detailed manuals on parts replacement, with each barrier to facilitate 1 year of normal

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operation. Give particular consideration to system components which are not readily available from local or commercial sources and which are critical to the operation of the system.

PART 2 PRODUCTS

2.1 Vehicle Restraint System

The following features are required of the vehicle capture barrier:

1. The barrier shall be a K-12 certified vehicle barrier.
2. The barrier shall be capable of stopping a 15,000 pound vehicle traveling at a speed of 50 mph with less than one meter of penetration of the cargo bed.
3. The barrier shall have an elastic quality and be a restraint system rather than a solid barrier.
4. The barriers shall be reusable after a minimal maintenance effort.
5. It must be able to be deployed in less than 2 seconds.
6. The standard warning lights and safety signage associated with the barriers shall be included in the purchase.
7. The barrier must be functional in weather conditions ranging from -10 degrees F to 110 degrees F. All necessary heating and or cooling options required to achieve this temperature range of operation shall be included in the purchase.
8. The barrier shall span a width of 24 feet.
9. Any Barrier system that requires a pit and the use of hydraulic fluid will not be acceptable.
10. If a pit is required, drive power generation, or anchoring by hydraulics or fossil fuels shall not be accepted.

2.1.1 Failure Modes of Operation

The system shall be designed to prevent lowering of the barrier in the event of hydraulic, electric, or mechanical failure. Provisions shall be provided for manual operation of the barriers in the event of prolonged power outage.

2.2 CONTROL PANEL

A control panel and control circuit shall be provided to interface between all barrier control stations and the power unit. A control panel shall be provided for the inbound lanes and a separate one for the outbound lanes where the barriers are located. The control station is defined as the main control panel. The control circuit shall contain all relays, timers, and other devices or an industrial programmable controller programmed as necessary for the barrier operation. The control panel shall allow direct interface with auxiliary equipment such as card readers, remote switches, loop detectors, infrared sensors, and limit switches. Loop controllers shall not cause an automatic barrier raise following power loss or restoration. The enclosure shall be as indicated on the drawings. All device interconnect lines shall be run to terminal strips.

2.2.1 Main Control Panel

A main control panel shall be supplied to control barrier function. This panel shall have a key-lockable main switch with main power "ON" and panel

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"ON" lights. Buttons to raise and lower each barrier shall be provided. Barrier "UP" and "DOWN" indicator lights shall be included for each barrier. An emergency fast operate circuit (EFO) shall be operated from a push button larger than the normal controls and have a flip safety cover installed over the push button or toggle switch. The EFO shall also be furnished with an EFO-active light and reset button.

2.3.1 Safety Equipment

ALL LISTED SAFETY EQUIPMENT SHALL BE PROVIDED AND INSTALLED AT LOCATIONS TO BE DETERMINED.

2.3.1.1 Barrier Systems Sensors

The barrier system sensors shall consist of the following:

- a. Suppression Loops - Two inductive loops whose outputs shall be used to prevent barriers raising when a vehicle is within a prescribed distance of the barrier. The output of the loops shall override all barrier rise signals until one second after a vehicle clears the suppression loop.
- b. Speed Loops - Two inductive loops whose output shall be used to signal the barrier controller of a vehicle approaching at a speed greater than the posted speed (25 mph or less (recommended)). The speed loops shall cause the barrier control panel to annunciate a warning sound alerting the guard to make a decision as to whether the barrier should be raised or not.
- c. Wrong Way Loops - Two inductive loops whose output shall be used to signal the barrier control panel to annunciate a warning sound if a vehicle is attempting to enter the facility through the exit lane. The warning sound will alert the guard to make a decision as to whether the barrier should be raised or not.

The sensors shall be compatible with the barrier controller and shall function as part of a complete barrier control system.

2.3.1.2 Traffic Lights

Red/yellow 8 inch traffic lights shall be supplied for each entrance and exit to alert motorists of the barrier position. Traffic lights are not required for manual barriers. The yellow flashing light shall indicate that the barrier is fully open. All other positions shall cause the light to show red. Brackets shall be supplied to allow the light to be mounted a minimum 4.5 feet above the roadway pavement on a 3.5 inch outside diameter metal post or mounted directly on the crash gate.

2.3.2 Warning Annunciator

Provide a warning annunciator built into the barrier control panel that produces a pulsing audible sound when the speed loop detects a vehicle entering the facility with excess speed. Provide a warning annunciator built into the barrier control panel that produces a continuous sound whenever a wrong way loop detects a vehicle entering from the exit. The warning annunciator shall sound until a warning annunciator silence reset button is pressed.

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2.3.3 Heater

A waterproof barrier heater with a thermostat control and NEMA 4 junction box connection point shall be provided for de-icing and snow melting. The heater shall provide barrier operation to an ambient temperature of **minus 10 degrees F.**

2.4 FINISH

The barrier front shall be painted white and have 4 inch wide reflective red stripes 4 inches apart. The diagonal striping should point down and outward from the center of the device. Primer: Alkyd, Anti-Corrosive for Metal, one coat. Finish coats: 100 percent Acrylic, Waterborne, Semi-Gloss, two coats.

2.5 CONCRETE

The concrete shall conform to Section **03 30 00** CAST-IN-PLACE CONCRETE.

2.6 WELDING

Welding shall be in accordance with **AWS D1.1/D1.1M.**

2.7 PAVEMENT

After placement of the vehicle barrier, the pavement sections shall be replaced to match the section and depth of the surrounding pavement. Pavement shall be warped to match the elevations of existing pavement. Positive surface drainage, away from the vehicle barrier, shall be provided by pavement slope.

PART 3 EXECUTION

3.1 **INSTALLATION**

Perform installation in accordance with manufacturers instructions and in the presence of a representative of the manufacturer. Manufacturer's representative shall be experienced in the installation, adjustment, and operation of the **equipment** provided. The representative shall also be present during adjustment and testing of the equipment.

3.2 HYDRAULIC LINES

Place buried hydraulic lines in polyvinyl chloride (PVC) sleeves. Provide positive drainage from the hydraulic power unit to the barrier for drainage of condensation within the PVC sleeve.

3.3 ELECTRICAL

All control power wiring requiring compression terminals shall use ring-style terminals. Terminals and compression tools shall conform to **UL 486A-486B.** Roundhead screws and lockwashers shall be used to provide vibration-resistant connections. Connections between any printed circuit cards and the chassis shall be made with screw connections or other locking means to prevent shock or vibration separation of the card from its chassis. The electrical power supply breaker for the hydraulic power unit shall be capable of being locked in the power on and power off positions.

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3.4 MANUFACTURER'S SERVICES

Provide the services of a manufacturer's representative who is experienced in the installation, adjustment, and operation of the equipment supplied. The representative shall supervise the installation, adjustment, and testing of the equipment.

3.5 FIELD TRAINING

Provide a field training course for designated operating staff members. Training shall be provided for a total period of not less than 4 hours of normal working time and shall start after the system is functionally complete but prior to final acceptance tests. Field training shall cover all of the items contained in the [operating and maintenance instructions](#).

3.8 FIELD TESTING

Upon completion of construction, perform a field test for each vehicle barrier. The test shall include raising and lowering the barrier, both electrically and manually, through its complete range of operation. Each vehicle barrier shall then be continuously cycled for not less than 30 minutes to test for heat build-up in the hydraulic system. Notify the Contracting Officer at least 7 days prior to the beginning of the field test. Furnish all equipment and make all necessary corrections and adjustments prior to tests witnessed by the Contracting Officer. Any conditions that interfere with the proper operation of the barrier disclosed by the test shall be corrected at no additional cost to the Government. Adjustments and repairs shall be done by the Contractor under the direction of the Contracting Officer. After adjustments are made to assure correct functioning of components, applicable tests shall be completed.

-- End of Section --